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Inland Navigation Barges with Producer-Gas Engines

A fleet of fifteen 1000-ton barges, each equipped with twin-screw propellers driven by producer-gas engines, is now under construction by the Alabama & New Orleans Transportation Co. to operate between the coal fields of Alabama and the city of New Orleans, La. This company controls the Lake Borgne Canal, which connects Mississippi Sound with the Mississippi River at a point about 12 miles above New Orleans. The canal is the only water route connecting these two bodies of water and affords the only practical inside route from the mines to New Orleans. Hitherto Alabama coal has been brought to New Orleans by rail, but recent improvements in the Tombigbee, Warrior and Black Warrior Rivers by the United States Government, making these rivers navigable for vessels drawing up to 6 ft. of water, induced some New England capitalists to start construction and operation of the fleet of barges which is described here.

In the Open Sound

At the New Orleans Wharves

Figs. 1 and 2. Producer-Gas-Driven Barges En Route between Tuscaloosa, Ala., and New Orleans, La.
(Alabama & New Orleans Transportation Co.)

The route from the city to the coal fields is first up the Mississippi River, then through the Lake Borgne Canal to Mississippi Sound, thence through Mobile Bay to the Tombigbee River, up the Tombigbee River to its junction with the Warrior, up the Warrior River to its junction with the Black Warrior, which is followed to Tuscaloosa, Ala., the terminus of the line. The entire distance is about 500 miles and the river distance from Mobile to the head of navigation is about 444 miles. This has been improved by the government so that it is navigable for vessels drawing up to 6 ft. of water, and in the last few years lock improvements have been made so that passage can be completed in reasonable time.

Requirements of Design

The peculiarities of the different kinds of water courses throughout the route make the design of barges to traverse the line rather difficult. Seldom will one find rivers of a greater varying nature than the three which make up the navigable channel between the Alabama coal fields and tidewater. It has happened that these rivers have risen in 48 hr. from a mean low stage to a record high stage, a variation of 65 ft., changing the river from a peaceful wading stream to a turbulent raging current from 60 to 70 ft. deep. The banks are greatly variable; some are high and rocky, maintaining the river whether high or low in one and the same channel practically at one and the same width. Other banks are soft and flat, allowing the river to overflow rapidly, inundating all life and vegetation and resulting in a stream, straight as it may seem, covering a crooked channel and shallow banks. Another peculiarity of the river system is its extreme crookedness. It is indeed a fact that for many a mile the only proof the navigator has that he is reaching his goal is the current of the river and the change of scenery. Quite frequently there are places where after one or two hours the direct distance covered might only mean a mile or two. Very often it happens that it would be possible to throw a stone in the river over the land which was passed half an hour before.

It was necessary, or at least desirable, that the coal could be transported to New Orleans without breaking bulk; that meant that after the river was passed the same craft which was used had to enter and navigate safely Mobile Bay, in some places over 30 miles wide, and then suddenly go through a channel—Grant's Pass—which is considered dangerous navigation even for small launches. This channel is only 6 ft. deep and 100 ft. wide, and that in an open sound where head winds and side currents might set light craft adrift. The barge then had to enter the Mississippi Sound with its own peculiarities and deep and shallow places of tide and current. It then had to enter Lake Borgne which covers a surface of over 100 sq.mi. with no place deeper than 6½ ft. or perhaps 7 ft. of water. After this, the same boat had to pass through Lake Borgne Canal 100 ft. wide, 8 ft. deep and fairly straight, through the locks and enter the Mississippi River the last link in its chain of navigable channels.

In addition to these navigation difficulties other restrictions placed upon the required craft were those imposed by the dimensions of the locks, the swiftness of

the current, and the fact that the boat would have to pass through long stretches devoid of all human life and possible opportunities for repairing a breakdown. The final condition was the necessity for quick loading and unloading.

In former times the river was navigated at high-water stages by barges towed by stern wheelers, the main duties of which were to keep the barges from turning the sharp corners too fast. Another duty was to tow the barges near the lock and coax the individual barges one or two at a time through the lock. This demanded often an hour or two in passing one lock, which, when thirteen locks were to be passed, amounted to considerable time.

Design of Barges

To suit as near as possible the conditions impos[ed] these difficulties the transportation company has ha[d] signed and is now building unit barges which are self-driven freight carriers. With these the time of locking is cut down to about 10 min., saving practically 24 hr. in the trip. The ideal barge to be designed should fit the locks as near as possible. The dimensions permitted by the locks were 256 ft. length, 52 ft. width, and 6 ft. draft. The width of the boat, however, was again limited by another condition; that is, the necessity of these barges passing each other in Lake Borgne Canal. This limitation brought the width of the barge to 32 ft. As

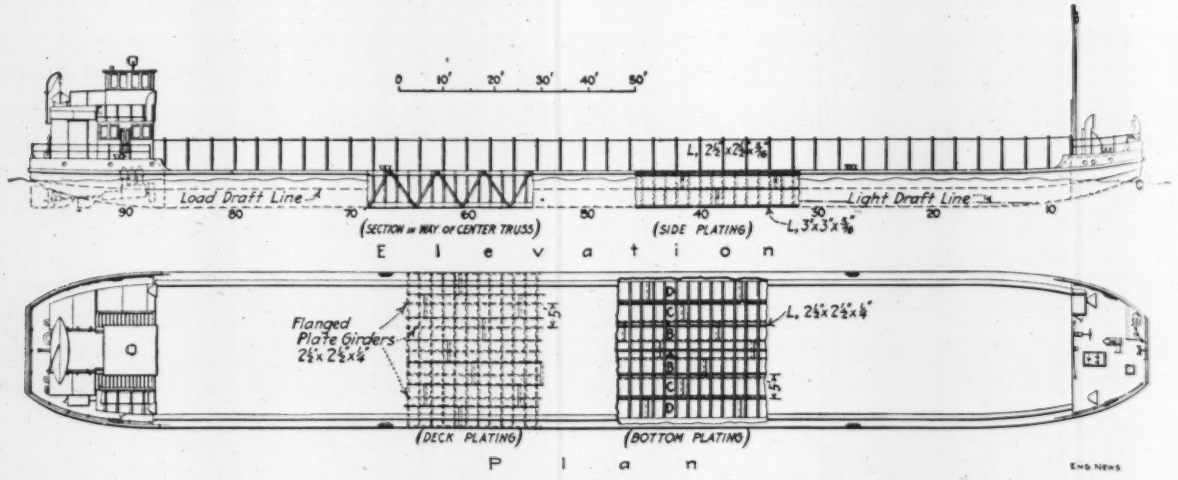


FIG. 3. GENERAL DETAILS OF BARGE

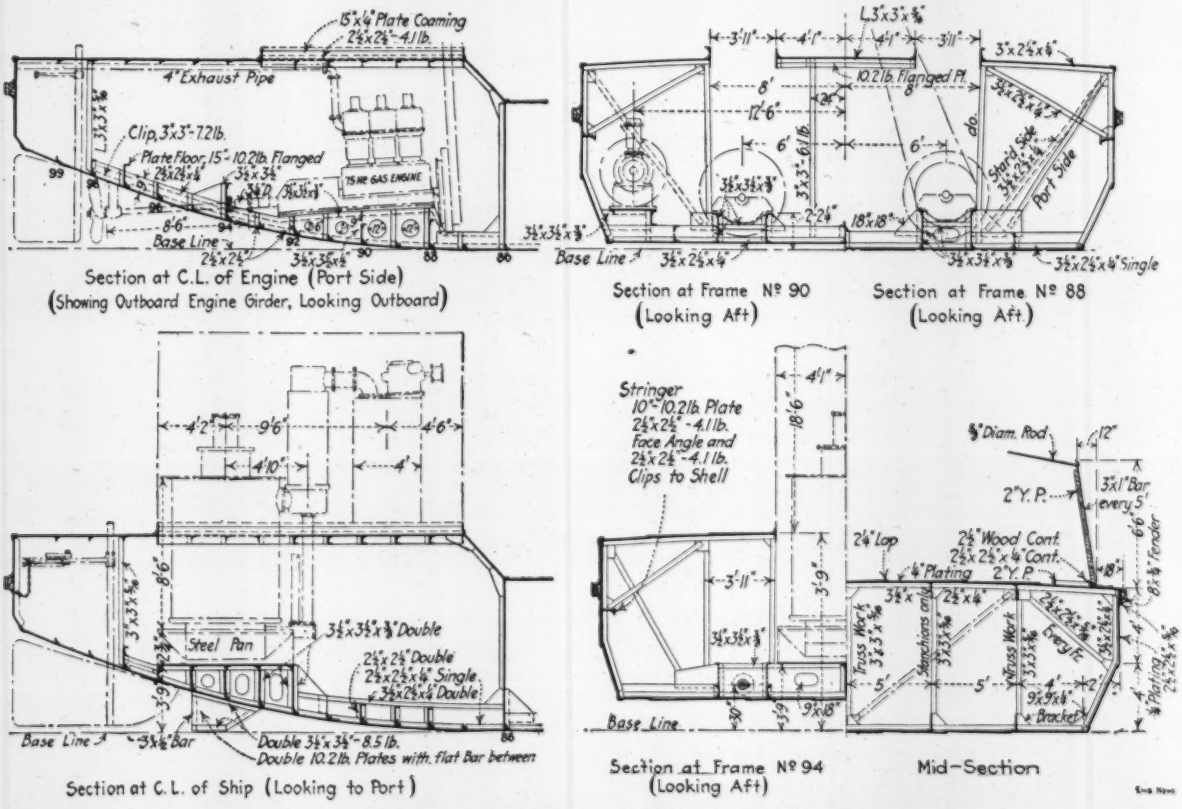

Section at C.L. of Engine (Port Side)
(Showing Outboard Engine Girder, Looking Outboard)
Section at Frame Nº 90
(Looking Aft)
Section at Frame Nº 88
(Looking Aft)
Section at C.L. of Ship (Looking to Port)
Section at Frame Nº 94
(Looking Aft)
Mid-Section

FIG. 4. DETAILS OF FRAMING OF GAS-ENGINE-DRIVEN BARGES

it would not do to build a barge so long that it would just about fit the locks, the length of 240 ft. for each barge was decided upon, which at a draft of 6 ft. gave a possible gross tonnage of 1300 tons.

The next problem was to have as little dead weight as possible, leaving as much carrying capacity as could be, with as much shape as could be given under these conditions to produce the proper speed and as much steering ability as could be gained under these limitations.

FIG. 5. ONE OF THE BARGES UNDER CONSTRUCTION

It was decided to make the shape of the barge like those used in the canals at Amsterdam, Holland, though on a larger scale. Figs. 3-4 shows the details of one of the barges which has been built. It has been designed so that the load would be a deck load, the space between the deck and bottom being utilized entirely for bracing purposes, so that steel is placed to the best advantage, making the barge in the nature of a hollow beam loaded above with freight and equally loaded underneath with hydraulic pressure. These two loads are held separate by a great number of stanchions, thus practically placing this hollow floating beam under the stress of compression without bending moment. The result is that the barge is subjected to greater stresses when unloaded than when loaded.

Another advantage of the design is that through the ability of meeting each load immediately by counter-pressure the various members are loaded only along their lines of greatest resistance and can be built comparatively light. As it will be noted, the barges on the inside show nothing but a collection of stanchions of 3½x3½x¼-in. angle irons. The entire barge is built up of interchangeable plates of the same length and width and ¼-in. thickness, and the frames are made up of a combination of 3½x3½x¼-in. angle iron.

It has been possible to design a barge with such a bow and stern that it is a model for speed, the best proof of which is the fact that with a capacity of 1000 tons it is propelled when empty at the rate of 9 miles per hr. with a 150-hp. engine; when loaded fully, at about 7½ miles per hr. The reason of this, it is stated, is that the peculiar construction has done away entirely with the bow wave.

SHIPYARD

The simplicity of the design of the barges made it possible for the company to build its own shipyard and get the raw material from the mill, doing all its own construction work. This amounted only to the installation of some electrically operated punches, a couple of angle-iron shears, some angle-iron benders, and a compressed-air plant for pneumatic hammers. Fig. 6 shows the yard with three of the barges in various stages of construction.

The equipment of the yard was very simple, but the company faced a serious problem in finding necessary labor. The shipyard being located at Lake Borgne Canal, 12 miles below New Orleans, not an industrial city, the only possible source of supply for the labor was the negroes out of the sugar-cane fields. These men were entirely inexperienced in shipyard work, but soon picked up the simple details of the construction of the barges. The steel blocks are first laid, and next the entire barge assembled, the frames having been made beforehand. The bottom plates are first laid down flat, then the frames placed against these plates, the side plates brought against them and the deck plates laid on top. All this is bolted together rapidly and subsequently riveted. Six months after work started the shop was driving rivets at a cost well below the established cost at the Great Lakes, the flat rivets costing very little more than two cents and a head rivet costing about 1¾c. each. A healthy rivalry between various gangs was encouraged by means of a bonus system for the gang who drove the most rivets.

The simple construction reduced the dead weight of the barge to a minimum. The hull with machinery weighs about 220 tons, drawing when empty 2 in. forward and 2 ft. 8 in. aft.

The sharpest bend in the river has a radius of about 380 ft., and it was necessary to build a barge to navigate such a curve successfully. It was equipped, therefore,

FIG. 6. VIEW OF SHIPYARD OF ALABAMA & NEW ORLEANS TRANSPORTATION CO.

with twin propellers, each driven by a 75-hp. engine 5 ft. from the center and steering was done with three rudders, the middle one being balanced. By putting the runners amidship, backing one propeller and forwarding the other, the barge can be turned in a little over its own length if it is stopped. It was found practical, however, to turn the barge when moving at full speed by bringing all three rudders hard aboard with a radius of less

than 300 ft.; in other words, the barge can navigate the sharpest bend in the river at full speed.

In summary, the barges are of steel construction 240x32 ft. on the deck, 28 ft. wide on the bottom and 8 ft. deep, with a carrying capacity of 1000 tons on a draft of 7 ft. All cargo is carried on the deck, sideboards being fitted as required. The total weight is about 220 tons, of which 180 tons is for the hull and 40 tons for the machinery.

Propelling Machinery

The engine room of the barge is equipped with two 75-hp. vertical gas engines. The engines are spaced 12 ft. apart and drive three-bladed propellers, 42 in. in diameter and 30 in. pitch, running in opposite direction at a speed of 300 r.p.m. The gas is generated in a producer from breeze coke. The producer is fitted with a water bottom and its equipment includes a scrubber, a gas tank and belt-driven tar extractor. The fuel is pea-size coke from the Birmingham coke ovens, the size to pass over a ¼-in. screen and through a 1½-in. screen. Its calorific value is about 11,000 B.t.u. per pound and the consumption is about 1 lb. per hp.-hr. It has been until now a waste product, used mainly for roads and ballast.

A 9-hp. gasoline engine is provided to operate a blower from the producer and a centrifugal pump for handling bilge water and water ballast. It also operates a 5½-kw. generator when the main engines are not running. A 4-in. centrifugal pump is driven from one of the main engines by a paper friction wheel and each engine has a centrifugal circulating pump for the cooling water. The generator is so arranged that during the voyage it is driven from one of the main engines by means of a belt. It furnishes current for a searchlight of 3200 cp., incandescent lights, electric fans in the engine room and cabin, and a 5-hp. motor operating the anchor windlass.

The remarkable feature of the whole equipment is that with a crew of two pilots, two engineers, two deckhands and a cook, 1000 tons of coal can be moved at the rate of 200 miles per day at a total fuel cost of two tons of breeze coke. This coke is extremely cheap, bought as low as 25c. per ton.

Operation

Figs. 1-2 give two views of Barge No. 1 in the open sound and at the dock at New Orleans. With the terminal facilities and easy access to the loading space, there being no hatchways, it is possible to load the barge with 1000 tons in two hours and unload it in three hours.

The owners state that the simple construction of the barge meets the requirements placed on it on account of the thinly populated country passed through, and consequently the lack of shipyards, as no plate needs any difficult operation which cannot be done by hand anywhere in the river when a barge might be stranded and no part of the barge is so large that it cannot be handled easily without heavy cranes. The fact that the whole of the barge is not used for cargo permits of its being made airtight by making the deck water- and air-tight and shutting the hold off by two bulkheads from the engine room and crew's quarters, with the result that the water in case of a leak cannot enter the barge faster than it could blow the air out of the hold, giving the barge ample time to sink and the captain ample time to reach a shallow place.

As stated above, the barges are being built by and for the Alabama & New Orleans Transportation Co. Mr. John H. Bernhard is Vice-President and General Manager of this company, and is in charge of the work. We are indebted to Mr. Bernhard for much of the information given above. The design of the barges was made by the Great Lakes Engineering Works, of Detroit, Mich., and the engines were designed and built by Fairbanks, Morse & Co., of Chicago, Ill.

Sewage-Treatment Works with Motor-Driven Reversible Distributor, Springfield, Mo.

Two sewage-treatment plants were put in operation at Springfield, Mo., early in 1913. The plants serve the two drainage districts of the city, and are alike except in size and method of sprinkling or percolating filter distribution. The larger plant has a daily capacity of about 3,500,000 gal., and has a traveling distributor, while the smaller one has a capacity of only 500,000 gal., and has nozzle distributors. Alex. Potter, of 50 Church St., New York City, was the engineer for both plants, with A. H. Beyer in charge of the design of details and with H. C. Atwater as resident engineer. The plants were built for about $76,000 and $15,000, respectively, by J. C. & E. T. Likes, of Des Moines, Ia., as contractors. The foregoing statements and the following additional information are from a paper by Mr. Potter, read before the American Society of Municipal Improvements, in October, 1913. The original paper was fully illustrated, but we show here only the traveling distributor and also confine the text principally to that.

Springfield had a population of 34,000 in 1910, and now has an estimated population of 46,000. It has an area of 14 sq.mi. and about 105 mi. of sewers. The sewage of each drainage district discharges into streams of small summer flow. The further information here given will be confined to the larger plant, the nature and extent of which is concisely stated by Mr. Potter as follows:

> It consists of a grit chamber built in duplicate, two settling tanks of the two-story [modified Imhoff—Ed.], a sprinkling filter divided into six units, each 53 ft. 9 in. wide and 200 ft. long, a sludge bed 0.35 acre in extent, and a final settling basin of 150,000 gal. capacity located at the outlet 3600 ft. from the remainder of the sewage-disposal plant.

The reinforced-concrete Imhoff tanks depart from the usual design chiefly in (1) the substitution of vertical members and struts for the walls, thus making each unit a single large upper or settling chamber, shaped like a four-leafed clover, instead of two or four smaller units, rectangular or with sides partly straight and partly curved; (2) in having a provision for "vertical circulation" between the upper and lower chambers; and (3) in some details of sludge discharge and of ventilation of the sludge chamber.

Sprinkling Filters and Traveling Distributors—These may best be described in Mr. Potter's own language, as follows:

To reduce the loss of head to a minimum, power-driven mechanical distributors are used to distribute the sewage on the filters. These distributors were manufactured by

the Ham Baker Co., of London, England. They are designed to distribute the sewage upon the beds with a loss of head not to exceed 12 in. when the liquid is applied at the maximum rate of 720 gal. per square yard per day. Fig. 1 shows the construction of one of these distributors. Each distributor is supported on three rails, spaced 25 ft. c. to c. The length of the travel is 200 ft.

The affluent from the settling tanks is conveyed by a 24-in. reinforced-concrete pipe to a main distributing trough located at the north end of the filters. The lateral distributing troughs which supply the traveling distributors are fed by 3-ft. weirs from the main distributor. The object of these weirs is to insure a uniform distribution of the liquid to the distributors. . . .

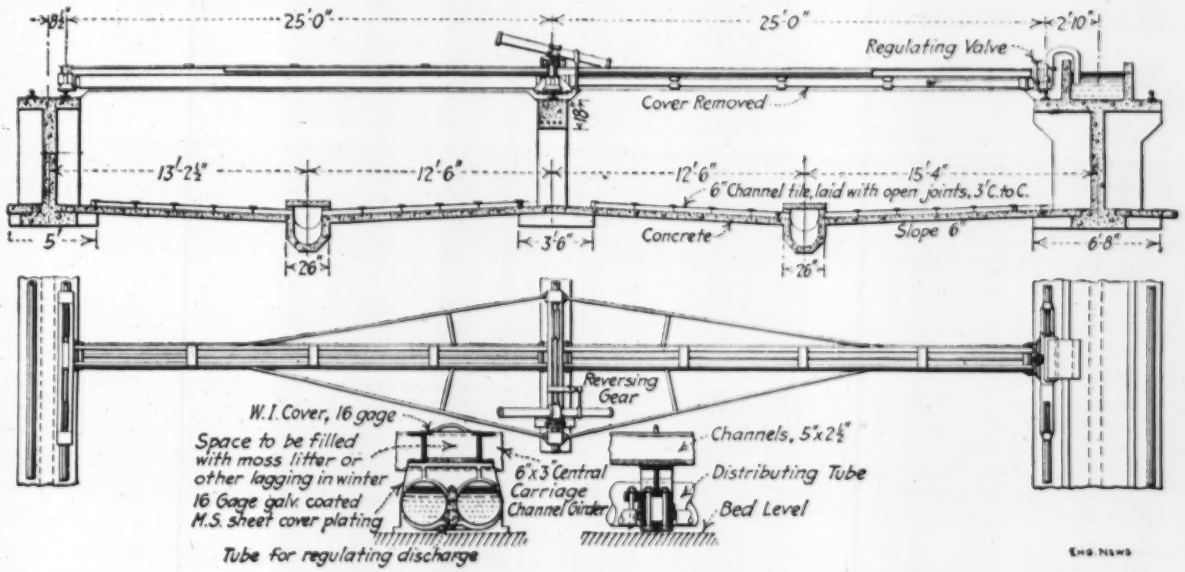
The rails on which the distributors travel are supported by concrete girders carried by piers spaced 12 ft. 5¼ in. c. to c. The area covered by each distributor is inclosed by an 8-in. concrete wall. The winter temperature of Springfield is sometimes so low that it may be questionable as to whether the traveling distributors can be successfully operated in extreme weather. Should the traveling distributors go out of commission or any of them break down, it is possible to utilize the filters or any unit thereof as a contact bed to be operated by hand, suitable gates being provided for this purpose.

Extending down the center of the filters between two of the traveling distributors is a 3-ft. rectangular conduit in which the normal depth of sewage is 16 in. A cast-iron siphon, 24 in. long and 8 in. in width, conveys the liquid from this trough to the distributor. This siphon is provided with a gunmetal air cock and brass air exhaust pump for starting the flow. The siphon discharges into the feed tubes, of which there are two. These feed tubes are made of wrought iron $\frac{3}{8}$ in. thick, and have an external diameter of 7⅜ in. The feed tubes are supported at each end and at the center by a cast-iron carriage braced together by rolled-steel beams, so as to form a rigid structure. In each feed tube just above the center are located ⅝x4-in. orifices, spaced about 15 in. lengthwise. The even distribution onto the beds is accomplished by a distributing tube 2½ in. in diameter, located between the feed tubes. This distributing tube is built in sections and can be raised or lowered as required to control the flow of sewage upon the beds. The feed tubes are protected with galvanized sheet-iron covers provided with hinged access doors. The protection extends to within 1 in. of the surface of the bed in order to conserve the heat in the sewage as much as possible, especially during the cold weather. It also acts as a preventative of flies. A space is provided between the two channels supporting the feed tubes, which during the cold weather is to be filled with moss, leaves or other insulating material.

Each pair of distributors is operated by an endless wire cable. All three sets of cable are driven by a 6-hp. Otto gasoline engine, which gives the distributors a speed of 38 ft. per min. The change in direction of the distributors is accomplished by means of the reversing lever shown on Fig. 1.

The distributors have realized every expectation. Less than 2 hp. is required to drive all six distributors. The writer believes that the distribution of the liquid over the bed is more uniform than can be obtained by the methods now in use in this country. The more uniformly the liquid is distributed upon a filter, the greater the quantity of sewage that can be applied to the filter to obtain the same degree of purification; or, with a given quantity of sewage, the more uniform the distribution, the greater the purification.

To the knowledge of the writer this is the first time that power-driven traveling distributors have been used in this country. The range of temperature at Springfield makes this installation an important one as indicating possible limitations of service in extreme winter weather without covering the filters.



MOTOR-DRIVEN TRAVELING SEWAGE DISTRIBUTOR, SPRINGFIELD, MO.

A 250-Mile Pipe Line is being built for H. M. Byllesby & Co., of Chicago, from the West Virginia Gas Fields to Louisville, Ky. Some 76 miles of difficult construction through the mountains has already been completed.

The 400-Ft. Steel Chimney of the United Verde Copper Co., at Jerome, Ariz.

By C. W. Cromwell*

The United Verde Copper Co. is building as a part of its new works, at Jerome, Ariz., a chimney which is believed to be the tallest steel stack in the world. This chimney is 30 ft. in diameter inside the brick lining, 30 ft. 9½ in. inside of the steel shell, and 400 ft. 1 in. from top of foundation to top of steel. The unusual size of this structure, the connections for three flues, and the protection of the steel plate from the flue gases, caused several interesting problems in the design.

The diameter and height of the chimney were determined by the draft calculations; the diameter and height of bell were made one-eighth of the height of chimney, or 50 ft. The brick lining was supported on the legs of circular angles riveted to the inside of shell and spaced 15 ft. apart. By this method, the bearing capacity of the brick is not exceeded and any section can be replaced without affecting the others. The weight of brick is carried directly down the shell and was added in when computing the maximum stresses on the compression side, but was neglected on the tension side as it was assumed that the maximum wind might occur before the chimney was lined.

The wind load was assumed to be 50 lb. per sq.ft., or 25 lb. per sq.ft. on the projected diameter, equal to 770 lb. per ft. of height. The dead load was taken as the actual weight of steel plus the weight of brick lining assumed at 112 lb. per cu.ft. The following unit stresses were used: Tension, 16,000 lb. per sq.in., on net section; compression, 10,000 lb. per sq.in., on gross section; shop rivets, 10,000 lb. per sq.in. for shear and 20,000 for compression; field rivet values 80% of shop. The section modulus of any section was computed by multiplying the area of the inside of shell by the thickness.

In order to find the points where assumed sections of plates and spacing of rivets changed a formula was derived as follows to eliminate the customary "cut and try" method.

Then

$$S_c = \frac{r}{at} \qquad (1)$$

$$S_t = \frac{r}{(a - d - \frac{1}{8})\,t} \qquad (2)$$

$$\frac{M}{M_s} = \textit{actual stress due to wind on either tension or compression side of chimney} \qquad (3)$$

$$\frac{M}{M_s} + h W_s + h W_b = \frac{r}{at} \text{ or } \frac{4620\,h^2}{M_s} + h W_s + h W_b = \frac{r}{at} \quad \text{(compression side)} \qquad (4)$$

$$\frac{M}{M_s} - h W_s = \frac{r}{(a - d - \frac{1}{8})\,t} \text{ or}$$

$$\frac{4620\,h^2}{M_s} - h W_s = \frac{r}{(a - d - \frac{1}{8})\,t} \quad \text{(Tension side)} \qquad (5)$$

Where

h = Distance in feet from top of chimney to section in question;

r = Least value rivet in shear or bearing;

d = Diameter of rivet in inches;

a = Distance between rivets in inches;

t = Thickness of plate in inches;

W_s = Weight of column of steel 1 ft. high. (For 1 sq.in. of steel is weight on circumference of length $\frac{1.0}{t}$);

W_b = Weight of brick as above. (For 1 sq.in. of steel is $\frac{3.0}{t}$);

S_c = Allowable compression per square inch on steel plate, to develop rivets in joints;

S_t = Allowable tension per square inch on steel plate, to develop rivets in joints;

M = Moment from wind in inch-lb. = $4620\,h^2$;

M_s = Section modulus.

All the quantities in the above equations are known except h, which can be readily solved from (4) and (5) as a quadratic. The minimum value found in the two equations should be used, which was always to be on the compression side. This method proved to be a great labor saver, the known values were substituted in equations (4) and (5), and getting these equations in the form of the standard quadratic $ah^2 + bh + c = 0$, the value h became $\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$, which was solved by the aid of the slide rule. An example of the use of the formula will be given.

To find the limiting distance h with ¼-in. plate and ⅝-in. rivets spaced 2¼-in. centers.

$\frac{3000}{2\frac{1}{4} \times \frac{1}{4}} = 5330$ = allowable compressive stress in plate.

$\frac{3000}{1\frac{3}{8} \times \frac{1}{4}} = 8725$ = allowable tensile stress in plate.

Weight of steel per linear inch circumference is 0.2... 3.92h for 1 sq.in. of steel. Weight of brick per linear inch circumference is 3.00h, or 12.00h for 1 sq.in. steel.

Total per linear inch circumference is 3.98h, or 15.92h for 1 sq.in. steel.

Then, $\frac{4620h^2}{26750} + 15.92h = 5330$, and h = 140 ft. = allowable depth on compression side.

Also, $\frac{4620h^2}{26750} - 3.92h = 8725$, h = 238 ft. = allowable depth on tension side.

This shows that the assumed plate and rivet spacing should extend 140 ft. from top of chimney.

The first change in section was designed to be made at 160 ft. from top of chimney, and the others at 58, 29, 29, 22, 22, 7½ and 22½ ft. farther down, but this spacing was slightly changed to fit plates ordered. The thickness of plates, diameter of rivets, and details of joints are shown in Fig. 1. The bell was made of 36 plates $\frac{11}{16}$ in. thick running vertically, with one horizontal butt-joint splice, to top of bell. Two plates 26x⅜ in., with four rows of rivets each side connected the bell with the main shaft. These plates were made unusually large to give additional stiffness and prevent any possible tendency to flatten the shell due to the curvature of the bell.

At the top of the bell it was necessary to provide three openings 120° apart for the reverberatory, blast-furnace and roaster flues. The sizes of these openings are given on Fig. 1. The bottoms of these openings were at the same elevation—the top of the bell. At these openings a lower unit-stress was used on the shell plate, and at each side of them the plates were reinforced as shown in detail. This T-section reinforcement was designed as a column

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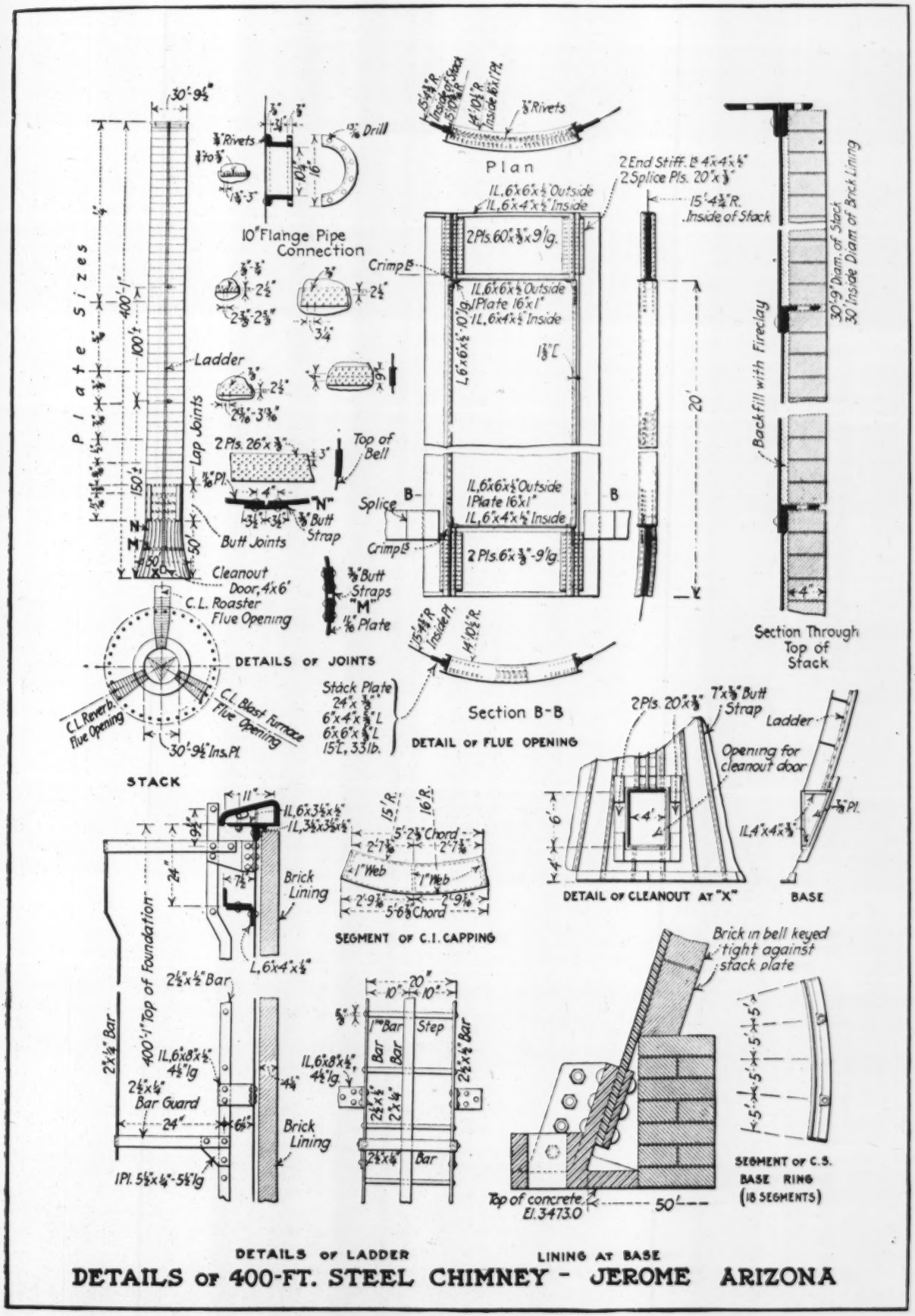

DETAILS OF 400-FT. STEEL CHIMNEY - JEROME ARIZONA

to take a load equal to the maximum stresses the plate in half the opening would have taken. At the tops and bottoms of these openings, built-up girders were riveted

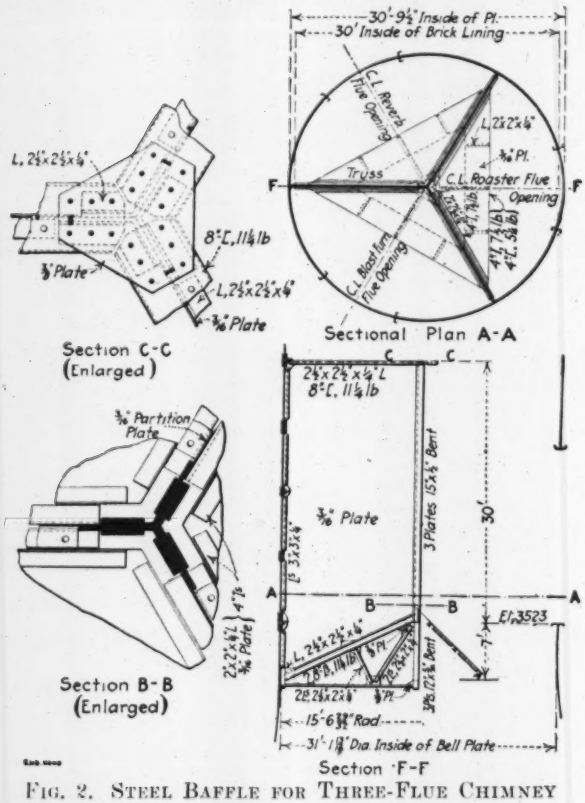

FIG. 2. STEEL BAFFLE FOR THREE-FLUE CHIMNEY

to both sides of the shell plates, and were designed to take load equal to the maximum stresses at these points.

The top of chimney is stiffened by outside and inside angles, the former supporting a cast-iron coping made up of 18 segments. This coping protects the steel and makes a good finish for the top. Two feet below the top there is a built-up Z-section with the outstanding leg turned up. This section acts as a strut and is to be used as a painting ring.

As previously stated, the brick lining is supported every 15 ft. by angles riveted to inside of shell; the angles are spliced and also act as stiffeners for the shell. At the bell the brick lining rests on the foundation and follows the contour of the bell to the top without any supporting shelf angles. Standard-size common brick is used, as in the remainder of the chimney, laid in rings and keyed against the bell plate.

There is a steel ladder running from bottom to top of the chimney and two feet back is a vertical bar connected to the ladder every 5 ft. and acting as a guard.

At points 150 and 250 ft. from the base there are flanged pipe connections with bolted cover plates to allow for inspection or tests. There is a large cleanout door at the base used also for erection purposes. Between adjoining flue openings, there is a baffle-plate extending from the shell to the center of chimney. These baffles extend from about 7 ft. below the bottoms of the flue openings to the full height (30 ft.) and cause the flue gases to come together while moving in practically parallel courses.

At the bottom of the bell, the plates are triple riveted to a cast-steel base ring, made up of 18 segments which are bolted at flanged ends and spliced with a reinforcing plate. This ring is connected to the foundation by 36 anchor bolts 4 in. in diameter by 11 ft. 2 in. long. At the lower end of these bolts a cast-iron washer 1 ft. square gives them a positive connection under the reinforcing rails.

The foundation is octagonal with a short diameter of 70 ft. and a depth of 10 ft. Piers for some of the flue columns are connected to this foundation but do not affect the general design. It is made of concrete with mix proportions of 1:3:6, the lower 3 ft. with a maximum of 2½-in. stone, the next 5½ ft. with a maximum of about 18-in. boulders and the next 1 ft. 5 in. with 2½-maximum stone and a 1-in. finish of a 1:1 mortar. It is reinforced top and bottom with two layers of old 45-lb. rails laid at right angles. The underlying sand is a coarse gravel partly cemented. The maximum bearing pressure at toe is about two tons.

The total weight of this chimney is about 875,000 lb. The erection rigging consists of a steel frame of two decks, the upper one supporting a guyed derrick, the mast of which is at the center of the chimney. The falls are led down through the center of motion to the chimney

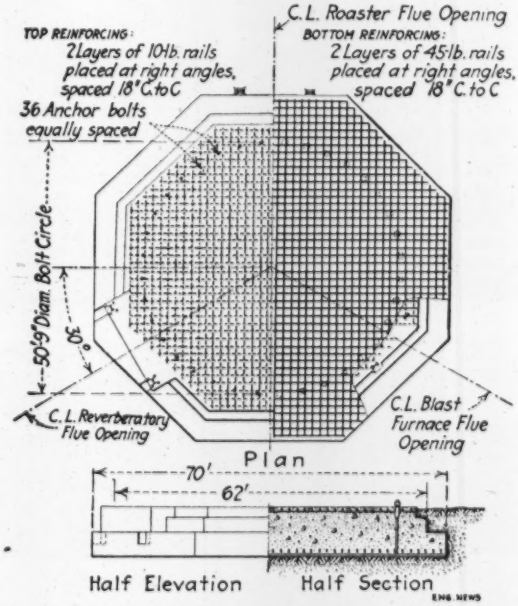
C.L. Roaster Flue Opening
TOP REINFORCING:
2 Layers of 10lb. rails placed at right angles, spaced 18"C. to C
BOTTOM REINFORCING:
2 Layers of 45lb. rails placed at right angles, spaced 18"C. to C
36 Anchor bolts equally spaced
50'-9" Diam. Bolt Circle
30°
C.L. Reverberatory Flue Opening
C.L. Blast Furnace Flue Opening
Plan
70'
62'
Half Elevation
Half Section

FIG. 3. FOUNDATION FOR 400-FT. STEEL CHIMNEY

base, and through the cleanout door to an electric hoist. The frame will be raised by means of chain hoists attached to the upper sheet of the chimney. For placing the brick lining a similar scheme will be used, the frame being raised by means of chain hoists attached to shelf angles. These shelf angles have been provided with holes for such connections.

The chimney was designed by Repath & McGregor, Engineers, Douglas, Ariz., who are designing the entire smelter. C. W. Cromwell, Structural Engineer, was in personal charge of the chimney design, with C. W. Brunskog as designing draftsman. The steel was fabricated and is being erected by the Chicago Bridge and Iron Works, of Chicago.

State Purchase of Railways in Great Britain

By H. Raynar Wilson*

A step of the greatest possible moment to railways, shippers and the traveling public in Great Britain has just been taken by the British government. Matters between the railroads and the shippers, and the railroads and their employees, have not been of the happiest for some time. For the time being there is no trouble with the men. That is pending and will probably come to a head some time next year when the amended conciliation scheme agreed to after the great railway strike of August, 1911, automatically expires—in November, 1914, to be exact. There is, therefore, no need at this time to refer to the relations with the men.

The traders have, for years, enjoyed many favors and privileges from railway companies for which they have not paid. They were the price paid by competing companies in order to obtain traffic. But in 1906 the railway interests in England agreed between themselves that this foolish competition should cease. Such privileges as free storage, excessive use of cars for storage, cartage beyond the usual free limits, payment of excessive claims, etc., suddenly ceased. One change made was the establishment of a Joint Claims Committee which considered every claim sent in by a shipper and no company was allowed to pay a claim, however just, until it had been approved by this committee.

From the railway point of view all this was within the companies' rights and it abolished all preferential treatment. But the shipper did not like it as it added to the cost of his railway charges and he therefore protested to the Government. This led to Government inquiry in 1908 when the shippers stated their grievances and the companies tabled theirs. In 1909 another inquiry was held and out of these two investigations came certain recommendations affecting both shippers and railways.

Before these recommendations could be legislated upon, there came the railway strike of August, 1911, which arose out of serious dissatisfaction among the men as to their conditions of service. The Government knew the position in which the companies were situated—that notwithstanding the greater cost of operation due to higher wages, they could not raise their rates to meet this cost without being challenged and at considerable expense and delay, with a possible defeat in the end. To grant the men's demands, however, meant certain increase in expenses and so the Government agreed to bring forward legislation to allow the companies to raise their rates sufficiently high to pay for the increased expense that granting the men's demands would involve.

Eighteen months ago the Government brought in legislation in accordance with its promise and at the same time, incorporated clauses therein to meet the recommendations of the two inquiries named above. The shipping interests were, however, so determined in their opposition to the increase in rates that they wrecked the whole Bill. As, however, the Government had promised this legislation, Parliament had to swallow it, and that part of the Bill was passed; but the shippers would not have the rest, even those clauses that were in their favor.

All this did not, of course, improve the relations between the two parties; and in debates on the above Bill, representatives of the Government admitted this and as a sort of stop to secure the sanction of the Bill, they promised an inquiry.

A Royal Commission has now been announced which is "to inquire into the relationship between the railway companies of Great Britain and the State in respect of matters other than safety of working and conditions of employment and to report what changes, if any, are desirable in that relationship."

The exact meaning of this was made clearer by a public speech made later by the President of the Board of Trade who is the head of that department of the Government dealing with railways. He said that the terms of reference had been drawn very wide so that the Royal Commission would be able to deal with every aspect of the problem. It would be enabled to consider and report to what extent and in what way steps should be taken to improve the relations; how far they should be based on a different foundation and even whether the State should itself undertake the responsibility of running the railways.

It has been too hastily concluded that the nationalization of British railways is the main purpose of the inquiry. This assumption is, no doubt, based on the wording "the relations between railway companies of Great Britain and the State" and finds confirmation in the remark of the President of the Board of Trade that the inquiry could cover the question whether the State should itself undertake the responsibility of running the railways. Such a step is, as yet, outside the bounds of practical politics although it must be admitted that the idea of State purchase has gained favor even among some high railroad officials. These latter, however, share these views because they see that the taking over of the railways by the State would relieve the officers of the present onerous task of trying to please the public, to keep the men contented and to satisfy their stockholders, while subject to constant interference by the Government in the interests of the shippers and the men.

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The Cause of "Red Water" (suspended iron oxide in municipal supplies) has been studied by A. T. Stuart, at the chemical laboratory of the Department of Agriculture Experimental Farm, Ottawa, Ont., and the results are reported in the "Journal of Industrial and Engineering Chemistry" of the American Chemical Society, November, 1913. Coils of iron wire and of iron-copper, iron-aluminum, and lead-aluminum combinations were suspended in bottles containing 400 c.c. of various waters to be examined. The tests were not carried beyond seven days, as it was felt that actual conditions in any city supply were then exaggerated. Raw and mechanically filtered waters from Watertown, N. Y., were used, together with raw, mechanically filtered, chlorinated, and magnesium-oxide precipitant samples from Ottawa. It was found that no appreciable difference existed in the action of raw or treated waters, so far as they could be revealed by losses in weight of the metals. There were, however, extreme and important differences in the character of the water. It was found that the raw waters, although corroding iron to the same extent as the others, did not coat the iron with as much flocculent material, nor did they allow the iron held to settle out, as is the case with treated waters, but retained a large proportion in solution or colloidal suspension. The treated waters, at ordinary temperatures, became very murky and opaque, and when hot, large amounts of brownish-red rust appeared ("red water"). From these it would appear that the state assumed by the iron taken from the immersed metal is a much more important question than the actual amount, and the inference is that the so called mechanical filtration of these waters is liable to bring about this trouble. The waters examined were of low mineral content and highly colored by peaty substances.

Grade Elevation and Six-Tracking at Rahway, N. J., Pennsylvania R.R.

By John Jervis Vail*

The Pennsylvania R.R. has now in course of construction on either side of the City of Rahway, N. J., about 21 mi. west of New York City, a 3½-mi. grade-elevation work, which includes both the elevating of the track above 12 street crossings in the city, and the increasing of the number of tracks from four to six. At present, the main line of the Pennsylvania west of Rahway is four-tracked, freight and express passenger trains being run on the two center tracks and passenger trains

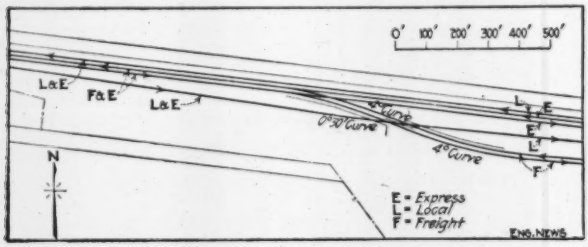


Fig. 1. Track Layout at Connection of Four-Track and Six-Track Line, Pennsylvania R.R. near Rahway, N. J.

on the two outside tracks. The new work involves the use of six tracks east of Rahway. The two freight tracks, eastbound and westbound, will be located south of the four passenger tracks, which latter will be operated, as in the New York subway, with the local trains on the outside tracks and the express trains on the inside tracks, island platforms being provided at express stations.

West of Rahway the freight trains will in future be operated as at present; that is, on the center tracks, but at the western boundary of the improvement work (Fig 1) these two center tracks swing to the south clear of the original roadbed and pass to their final location south of the four-track passenger line. The eastbound passenger track passes over these freight tracks on a bridge, and becomes the eastbound local track east of the crossing. The westbound or most northerly track of the four-track line continues as before, the westbound local, and the two center tracks continue on the new grade as the eastbound and westbound express tracks, all as shown on Fig. 1. About midway of the improvement is a tunnel undercrossing by which a two-track line is diverted from the main line to the New Jersey shore resort line.

The elevation is an earth fill throughout, except at the street crossings, which are of different types of steel and concrete bridges, with concrete abutments, and except also for the tunnels carrying the Long Branch line and the concrete bridge over the Rahway River. A clearance of 13 ft. is maintained over the streets, ten of which remain at their original grade, two only being changed to meet the new conditions. The whole cost of the improvement is borne by the railway company.

Method of Construction and Operation

During construction, four running tracks are maintained at all times. In general, the elevation is accomplished in three operations. Two new tracks are first built to the south of the present four-track line and placed in service without interfering with business on the four original tracks. The next two operations consist in elevating the low-grade tracks, two at a time. The first operation, with which these notes deal, was completed July 27, 1913, having been commenced in April, 1912. The quantities involved are as follows: Filling, 700,000 cu.yd.; concrete, 70,000 cu.yd.; steel superstructure, 2600 tons; tracks, 7 mi.

Fig. 3 gives sections through the track at different locations on the improvement, and illustrates the four different conditions that were met at various places in elevating the line. Condition No. 1 is that in which the filling for the preliminary two-track construction does not interfere with the original tracks. In this condition, a fill is made entirely to the south of the present four tracks. When this fill is completed, two tracks are placed on the elevated level, and used during construction, as the eastbound freight track and the eastbound passenger track. The second operation in this condition is the addition to fill so that it covers the two southerly tracks of the original four, and placing, when this fill is completed, the two westbound tracks on the upper level. The final operation consists in building a retaining wall at the extreme north of the line of the right-of-way, and elevating the last northerly section on which is placed the final two tracks. It will thus be seen that at all times four running tracks are maintained.

Condition No. 2 is that in which the fill encroaches on the original roadbed, and the low-grade tracks are moved north, preliminary to construction. In this, the southerly tracks are abandoned, preliminary to construction, and two temporary tracks are laid to the extreme north of the right-of-way. The southerly portion of the right-of-way is then raised to the upper level, and two tracks placed thereon. The second operation consists in using the two elevated southerly tracks and the two temporary northerly tracks while fill is being made in the middle of the right-of-way, and the final operation consists in raising the extreme northerly end of the right-of-way.

Condition No. 3 is that in which filling would encroach on original roadbed, and crib retainers have to be built. It is somewhat similar to condition No. 2 except for the use of the cribs. Condition No. 4 is that in which filling would encroach on original roadbed, and a temporary two-track line is located on a fill south of the final position.

Fig. 2. One of the Retaining Walls near Rahway

Construction

The filling for the earthwork was obtained from two borrow pits convenient to the work, and was handled

*Rahway, N. J.

on a narrow-gage track, dumping the earth from a trestle. This trestle was peculiar in that no timber stringers were used, but in their place 100-lb. rails having a span of 12 ft. from bent to bent supported the ties carrying the running rails. The running rails only, without stringers of any kind, sufficed when the trestle was in the fill and bore the weight of empty cars only. Where the trestle was not to be filled, four 100-lb. rails were used as stringers to carry the construction track. The ends of the 100-lb. rails were made fast by standard splices, and with the joints not necessarily at the bents.

The retaining walls and the abutments were all of the gravity type, with their base 35% of their height. They were built in sections 30 ft. in length, each section being a monolith and having its whole form filled to the top of coping at one pouring. In one case, however, a wall over 25 ft. high was built in two lifts. At the top of the first day's work a vertical offset 9 in. high

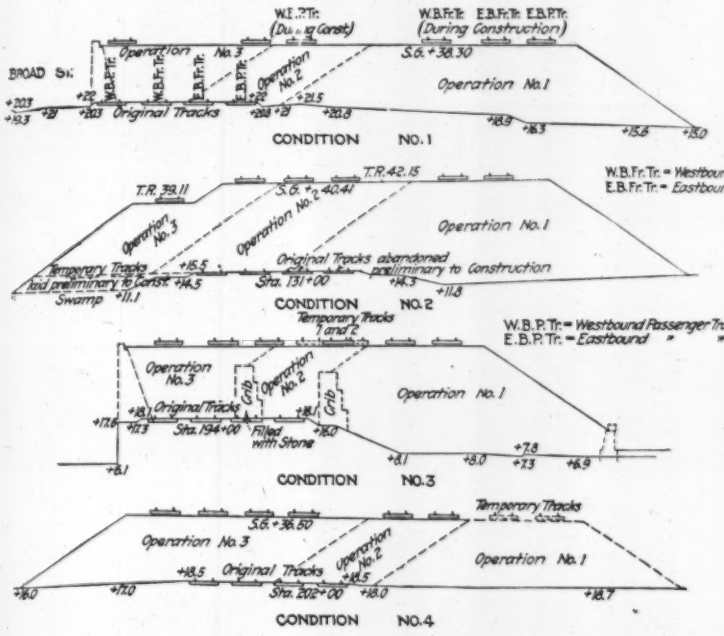


FIG. 3. PROGRESS OF THE ELEVATING OPERATIONS AT VARIOUS LOCATIONS

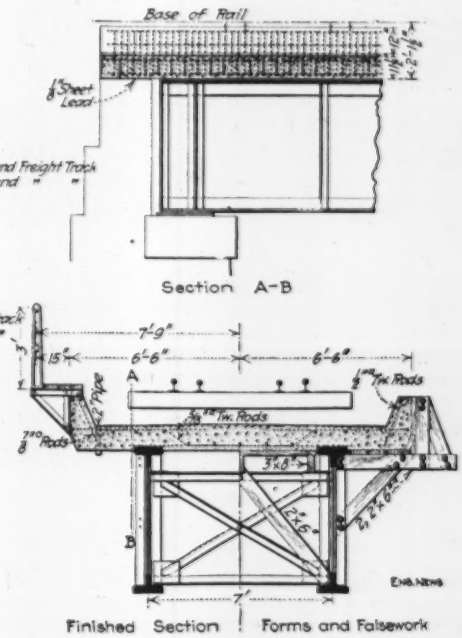


FIG. 4. GIRDER TYPE OF OVERHEAD CROSSING

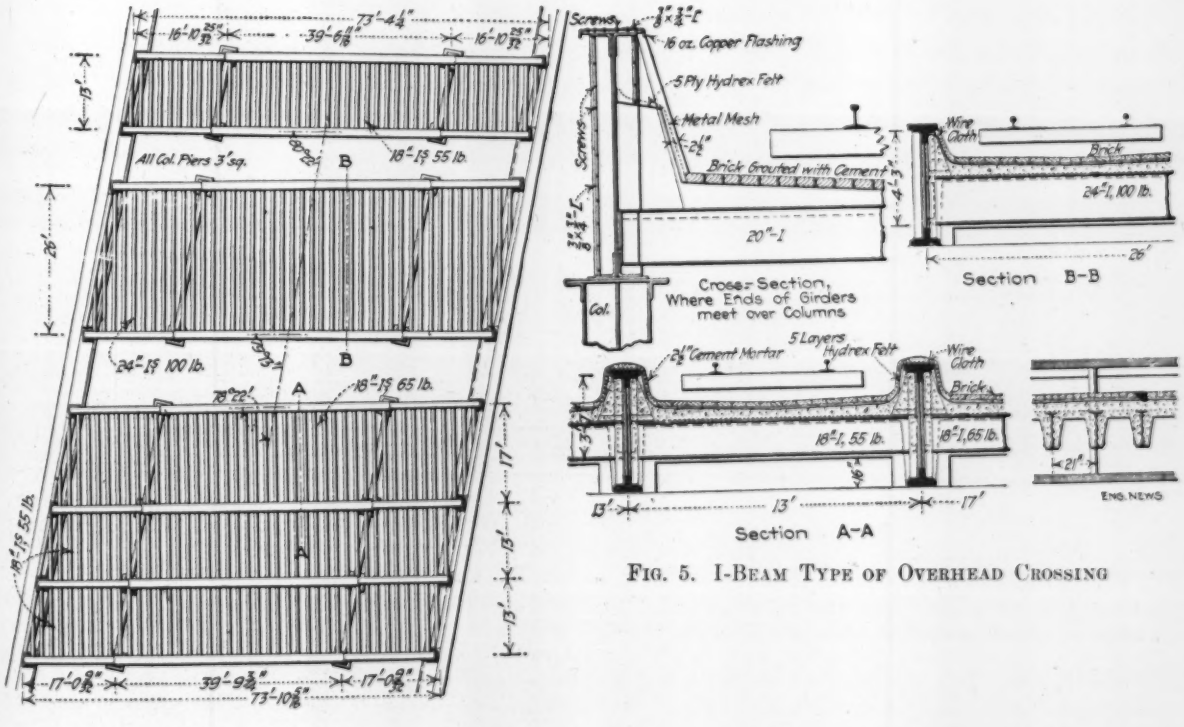


FIG. 5. I-BEAM TYPE OF OVERHEAD CROSSING

FIG. 6. PORTAL OF TUNNEL

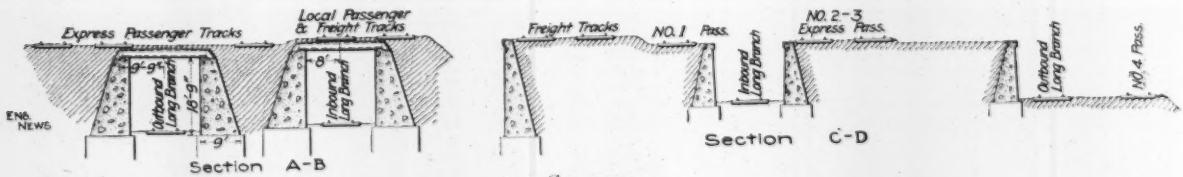
FIG. 7. SECTIONS OF THE TUNNEL

FIGS. 6-7. TWO VIEWS OF THE LONG BRANCH UNDERCROSSING BEFORE FILLING

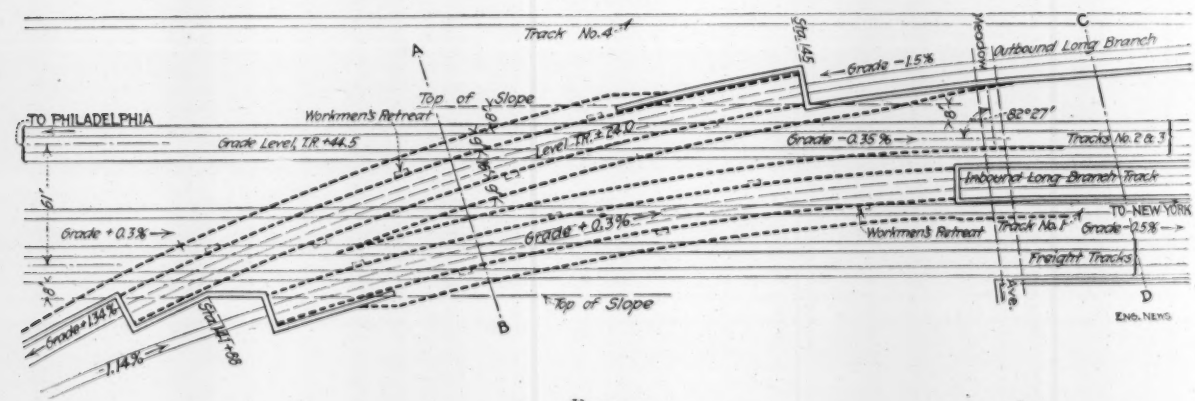
was formed at about the middle of the wall, running the length of the section. This has prevented the water finding its way through the horizontal joint and staining the surface. A dry rubble drain, 2x4 ft., was laid inside of the walls at their bases. At each expansion joint, and midway between, the drains ascend the wall to subgrade. Water is collected by them and passes through 4-in. cast-iron pipes to the face of the masonry. The concrete surface of the retaining walls was relieved by scoring, and a smooth face was obtained by rubbing with carborundum brick. All concrete was proportioned 1:3:6, except in bridge seats, arches and reinforced masonry, which were 1:2:4 mixtures.

Across the Rahway River the crossing is on three arches, 100 ft. total length each. The span of each arch is 60 ft., the rise 20 ft., with a thickness of crown of three feet. They are not reinforced. In laying them up, the concrete was deposited to fit certain architectural lines on the outside, so that the end of a day's concreting is defined by decided score marks on the bridge concrete surface.

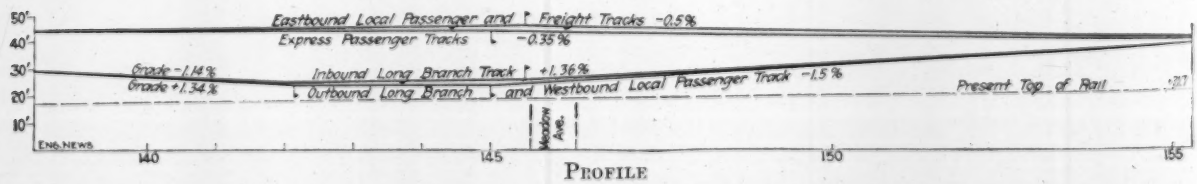
The street crossings are of two types. Where the street clearances permit, they are of the deck-girder type, shown in Fig. 4, having the reinforced-concrete slab to carry track ballast. Where clearance was too small, the type shown in Fig. 5 was used. Here columns are erected on the curb line and the track system is carried on I-beams resting on the lower flanges of the girders. The girders and I-beams are all protected by concrete. All bridges are waterproofed with five-ply felt, over which is laid a protective covering of brick, grouted with cement. The first layer of felt was dry and did not therefore ad-



SECTIONS



PLAN



PROFILE

FIG. 8. DETAILS OF CROSSING OF LONG BRANCH TRACK UNDER MAIN LINE, PENNSYLVANIA R.R., NEAR RAHWAY, N. J.

here to the bridge floor. When two girders butt together, it is sometimes difficult to prevent rainwater from penetrating between their ends. Where this condition exists, copper flashing was crimped over the tops of the girders where they meet, and is carried down their sides to below the level of the waterproofing. This detail is shown in Fig. 5.

All concrete was mixed in portable mixers, located at convenient places. At the various streets material was received in standard-gage cars, moved from cars to mixers by hand, and lifted to the forms by special derricks. At the Rahway River bridge, a mixing tower and cableway was set up. At Perth Amboy Junction, 35,000 cu. yd. were mixed by one machine, stone and sand being dropped from the cars standing on the trestle, and bucket conveyors lifting the material to the top of the tower. The mixer discharged into one-yard buckets, which were spotted to their destination and lifted into forms by a special hoist. Cement was conveyed by a belt running the length of the cement house. The whole plant was driven by electric power. In this plant 7000 cu.yd. were poured in one month, 10 hr. a day.

Figs. 6 and 7 are views showing construction of the tunnel undercrossing for the Long Branch tracks, and Fig. 8 shows the plan and details of this tunnel. It is, as will be seen, quite complicated in layout, though simple in its structural details. It consists primarily of four gravity retaining walls spaced in groups of two, each group being covered with I-beams incased in concrete to make the roof of the lower track and the floor for the upper track. The intermediate space between the tunnels, varying in distance, is filled with the general fill, which makes the elevation for the six-track line.

Personnel

The general contractors on the work were the Keystone State Construction Co. and the James McGraw Co. Brann & Stewart Co. erected the bridge superstructure. The construction is under the direction of W. C. Bowles, engineer of construction, acting under A. C. Shand, Chief Engineer, and E. B. Temple, Assistant Chief Engineer, all of the Pennsylvania R.R. It is expected that the work will be completed in December, 1914.

The Mississippi River Flood-Control Problem Summarized

In our issue of Apr. 17, 1913, we published the address of Col. C. McD. Townsend, President of the Mississippi River Commission, before the National Drainage Congress at St. Louis, reviewing the engineering problems in connection with flood control for the Lower Mississippi. This address has now been printed as a Senate Document (63d Congress, 1st Session, No. 204) and is prefaced by a very brief report by Col. Townsend to the Chief of Engineers. We urge all our readers who have not carefully posted themselves by the longer articles we have published, to read Col. Townsend's report printed below. It states the facts without the supporting data for their proof; but the facts are so well established that they should be accepted by engineers who have not themselves knowledge of the conditions because of the high authority back of them.

To the Chief of Engineers, U. S. A.

1. In compliance with instructions contained in your letter of Apr. 29, 1913, and on behalf of the Mississippi River Commission, I submit the following report upon:

(a) How best to prevent the occurrence of destructive floods in the Mississippi River Basin.

(b) How to prevent or reduce to a minimum the damages which might be caused by such floods.

2. Many of the questions involved have been discussed in great detail by the commission in its annual reports, but in accordance with your verbal directions this report is made as brief and concise as practicable.

3. The floods of the Mississippi River Basin are caused by heavy storms originating in the Gulf of Mexico. Like cyclones, earthquakes, and volcanic eruptions, they are acts of God, which man can not prevent; and the rainfall during these storms is so excessive that the works of man have little effect in increasing or diminishing the volume of the flow resulting therefrom.

4. Numerous methods to prevent or reduce to a minimum the damages caused by such floods have been suggested:

(1) Reforestation—While forests may have some influence on a river during midstages they produce little effect either during extreme floods or extreme low water. It takes too long a time for trees to grow and the humus to form under them for reforestation to be a practical solution of flood prevention in the Mississippi Basin. It would also require the abandonment of too much land needed for agricultural purposes.

(2) Reservoirs—In a mountainous country, where short high dams can create reservoirs of great depth and volume, or in a comparatively level country where low dams can form lakes of large area, it may be practicable to control floods by means of reservoirs. There is but a comparatively small section of the Mississippi Basin that fulfills either of these conditions, and in such areas the rainfall is generally light. The rolling country, which forms the greater part of the Mississippi Valley and from which the water that produces its floods is derived, can be protected from floods by reservoirs only by an enormous expenditure.

(3) Cutoffs—By cutting off the bends in a river, its length is diminished and slope increased. This would increase its discharge at a given height. This method of relief cannot be applied to the Mississippi River, as it would seriously injure its navigability during low water, and increase the caving of its banks which is now excessive. While it would afford relief in the upper portions of the sections of the river thus straightened, it would increase flood heights at the lower end, benefiting one locality at the expense of another.

(4) Outlets—Outlets, while locally reducing flood heights have only limited application as a means of relief from Mississippi floods. They cannot be constructed above the mouth of Red River; their influence on flood heights extends only a comparatively short distance above the locality where they are constructed; there is a tendency for the river to diminish its area of cross-section below them; they have to be protected by levees of the same dimensions as the river itself; and there is danger, if the outlet is made sufficiently large to be of practical value, that the river may abandon its present channel and adopt that of the outlet.

(5) Diversion of Flood Waters Into Channels Parallel to the Main River—The maximum flood discharge of the Mississippi River exceeds 2,000,000 sec.-ft., while it discharges about 1,000,000 sec.-ft., at a bank-full stage. A side channel which would discharge the excess flood waters would therefore require an area of cross-section equal to that of the river itself at bank-full stage, and with the same characteristics as to depth and velocity.

(6) Levees—Levees afford the only practicable means of preventing the damages which might be caused by floods in the lower Mississippi Valley. They have been successfully employed on European rivers, and are the only means of flood protection of large rivers that have been tested, or, if tested, have not failed. To restrain floods like those of 1912 and 1913, will require in the existing levee line about twice the yardage now in place. The estimated cost of such an enlargement is $57,000,000. Levee construction has not raised the bed of the Mississippi River.

(7) Floods have not increased either in volume or frequency in recent years.

C. McD. TOWNSEND,
Colonel, Corps of Engineers.

Extracts from the Annual Report of the Isthmian Canal Commission

LOCK MACHINERY

The complete installation for a set of rising-stem valves requires setting the valves, placing the stems, roller trains, crossheads, motors and control panels. It developed that the fixed ironwork for guiding the valves and for forming the water seals required correction before installation could be begun. For all the valves at Gatun and all but two at Pedro Miguel the corrections were made by chipping and grinding with pneumatic hand tools; for the two at Pedro Miguel and all the valves at Miraflores it was done by a specially designed milling machine; 94% of the fixed irons had been corrected at the close of the year. During the year 102 rising-stem valve chambers were prepared, and 104 valves, including trains and sealing devices, were placed in position in the locks.

Guard valves were provided as duplicates to the upper rising-stem valves in emergency, or for use in closing the intakes in the side-wall culverts for unwatering the culverts to permit access to other valves for painting and repairs. The design of the machinery for these valves was completed in August, 1912. On November 14, 1912, a contract was awarded for 18 complete machines, excepting the motors, limit switch, counterweight bases, and counterweights, and 50% of the machines were delivered before the close of the year. As the result of tests made to determine the leakage of the cylindrical valves, it was decided to regrind all valves so as to allow a maximum average opening around the seat of 0.004 in.

Tests were made to determine the time required to open the various types of valves, with the result that the cylindrical valves required 10 seconds, the 60-in. auxiliary culvert valve 16 seconds, and the 36-in. auxiliary valve 10 seconds.

All the spillway gate machines and pumps for unwatering the counterweight pits, purchased under contract, were delivered during the year and a satisfactory test was made of the first machine erected. The device for shifting the gate upstream a slight distance after it is clear of the water and the mechanism for raising the roller train out of the water after the pressure on the gate is relieved operated properly.

LOCK GATES

The construction and erection of the lock gates was continued during the year under contract with the McClintic-Marshall Construction Co. dated June 21, 1910. All shop drawings were completed, as was the manufacture of all material for the gates, aggregating 57,500 tons; the final shipment was made in April. In addition, about 2100 tons of structural work for spare parts were built and delivered on the Ishtmus, completing this part of the contract with the exception of a few castings, bolts and rivets. The spare parts comprise sufficient material for partly or completely rebuilding any two-gate leaves on the canal in case of accidental injury.

The work of erecting the lock gates proper began at Gatun, May 17, 1911, at Pedro Miguel August 7, 1911, and the first work at Miraflores was done on September 10, 1912. At the beginning of the fiscal year work was in progress on half the total number in all the locks, but none of them had been entirely completed. The total amount of steel assembled was only 19,361 tons or about 34% of the total, and much of this was only partly reamed and riveted. The total number of field rivets was about 963,000, or about 18% of a total of over 5,700,000. The work had been allowed to drag so that the task of completing it within a reasonable time seemed hopeless.

The contractors decided upon a change in their local management and, beginning about Sept. 1, installed much additional machinery, largely increased their force, and arranged for more efficient supervision. Within a few months the improvements in the organization became manifest; a high degree of efficiency was reached, with a correspondingly large increase in the work done. Some idea of the improvement may be judged from the fact that during the month of March a maximum of 660,000 rivets were driven, while the highest number driven in any one month prior to September 1, 1912, was 213,000. On June 30, 1913, over 97% of all material was assembled in the gates. All the leaves in the west chamber at Gatun and in the east chamber at Pedro Miguel had been stepped on their pintles, and all the leaves in the west chamber at Miraflores, excepting the two leaves of the operating gate in the lower chamber. All the guard gates were complete except those at the lower end of Miraflores locks, and the guard gates at both ends of the Gatun locks had been permanently closed at the end of the fiscal year. Those at the upper end were put in service about July 20, 1912, and the lower guard gates were closed June 1[illegible]13; the latter sustain the maximum working head of a[illegible]40 ft. without appreciable leakage.

The total weight of all gates on the canal, ex[illegible]ing pumps, floats and float switches, motors and condui[illegible]and other electrical apparatus, the castings for attachi[illegible]the operating struts, and the miter forcing machines, is [illegible]52 tons. The total amount thus far expended is $4.82[illegible]82, of which $4,065,392.01 was paid under the contract, a[illegible]the balance of $754,627.31 was for inspection and division c[illegible]es.

The miter gate-moving machines had been installed [illegible]mplete on the upper guard gates at Gatun, and a test was made of this machinery on July 31, 1912. The gate-moving machine was adjusted so that when the strut arm was at dead center on the crank gear the gates were closed with a compression of the strut for one leaf of $\frac{5}{32}$ in. and for the other leaf of $\frac{3}{32}$ in.

The limit switches were adjusted so that the gate traveled from its full miter position to the opposite position in the recess, at which point the machine was again on dead center. The gates were started from a miter position and opened to their full position in the recess and again closed. The time of operation of one leaf was 1 minute and 51 seconds and for the other 1 minute and 50½ seconds. The operation was completed a second time. During both operations the mitering of the leaves was perfect.

The gates also had installed a miter-forcing machine which had been purchased under contract, and this was tested out on the same date, under approximately actual operating conditions. One leaf was left in its closed position and the other opened a distance of 2 in. The miter-forcing machine was then operated and it brought the gate to within ¾ in. of perfect miter. Another trial, with an opening of 3½ in., brought the gate to a point ⅝ in. from miter. During these tests the miter-forcing machine was operating against the resistance imposed by the strut. As the result of the test several changes were made and the option under the contract of purchasing the remainder of the miter-forcing machines required for all the locks was allowed to lapse and new proposals invited.

CHAIN FENDERS

During the months of March and April a number of tests were made of the chain fender. The first series consisted of raising and lowering the chain by operating the centrifugal pumps, and the general operation of the machine, including the action of the moving cylinders, girders, and the passing of the chain over the sheaves, was satisfactory from the beginning. The pumps and their motors were of sufficient capacity to raise and lower the chain in the specified time—one minute. The chain dropped uniformly from both lock walls and, in its final position, rested at the bottom for the full width of the lock chamber, with its vertical parts entirely within the chases in the walls. A second series of experiments was made by use of a Lidgerwood unloader to test the operation of the fender under conditions somewhat similar to those that will prevail when the chain is struck by a moving vessel. Under such circumstances the chain will gradually pay out, touching the curved surface of the hawsepipe castings in the walls, over a constantly increasing arc of contact. The movement will be resisted in part by the friction of the chain along the hawespipes, in part by the internal friction of the machinery, but mainly by the hydrostatic pressure which acts against the upper surface of the moving cylinder. In the final tests made the maximum pressure reached 630 lb. per sq.in., when the chain parted near or on one of the lower sheaves. This pressure corresponded to a stress on the chain of less than one-half the breaking strength obtained in the shop tests. The results obtained seem to warrant the belief that a vessel, unless of very great size or moving at excessive speed, can be checked or stopped without breaking the chain, provided the latter is structurally sound.

TOWING LOCOMOTIVES

Bids were invited for towing locomotives on design prepared by the electrical subdivision, and a contract was entered into for furnishing 1 locomotive with the option of purchasing 39 more, or of substituting for this locomotive one built according to the design submitted by the successful bidder. The locomotive was delivered on the Isthmus Jan. 25, 1913, and ready for operation Feb. 7, after which it was tested. The result of the test developed defects, so that changes and improvements were necessary in order to fulfill the conditions required. While the contract provided for making minor changes if found necessary, the changes and improvements which it was decided should be made in order to make the machine satisfactory could not be classed as minor ones. As a result, advantage was taken of the option in the contract and an order was placed for the required

number of locomotives on the design submitted by the General Electric Co., abandoning the design of the commission.

ELECTRIC DISTRIBUTION

During the year it was decided to install for the transmission line an overhead system of 44,000 volts, extending from Balboa to Cristobal, and connecting the Gatun hydro-electric power station with the present Miraflores steam-power station, so that they may be operated separately or in parallel, as necessary. Four substations are provided, and located at Cristobal, Gatun, Miraflores, and Balboa. The complete line consists of duplicate three-phase lines, one of which is carried on each side of track-span bridges spaced 300 feet apart on tangents and 200 feet on curves along the whole length of the Panama Railroad. The bridges are of structural steel, with a clear track span of 36 feet, and an overall height of 40 feet. The conductors are to be 2/0 stranded copper wire spaced with a clearance of 5 feet. They are supported from brackets outside of towers, with three-part suspension insulators, with noncorroding connecting links to allow a maximum life and a minimum of line troubles.

GATUN DAM

At the close of the previous fiscal year the Gatun Dam had been raised to an elevation of 103.35 feet for a length of 1000 feet east of the spillway, and for the balance of this portion of the dam the dry fills had reached a general elevation of 96 feet and the hydraulic fill between them a general elevation of 85 feet. On the portion of the dam west of the spillway the north and south fills had reached a general elevation of 98 feet and the hydraulic fill an elevation of 87 feet at the spillway and 78 feet at the drains located in the northwest corner of the dam.

At the close of the fiscal year just ended sufficient material had been added to raise the dam to practically its full height, with 3 to 5 feet additional along the axis to allow for settlement. The dry fill was secured from the borrow pit which had been opened during the previous fiscal year, beyond the west end of the dam, and the clay used to top off the hydraulic fill from borrow pits north of the dam and in the vicinity of the locks. From two to six steam shovels were engaged in procuring this material and removed 2,159,-159 cubic yards, borrow-pit measurement, of which 923,877 cubic yards were designated as rock. The hydraulic fill was supplied by three pipe-line suction dredges operated in borrow pits upward 1½ miles distant, the maximum lift being 100 feet. The total amount handled, borrow-pit measurement, was 493,145 cubic yards. The hydraulic fill was stopped of the dam the dry fills had reached a general elevation of in September, 1912. The cost of the dry fill in place amounted to $0.3755 per cubic yard and of the hydraulic fill $0.2654 per cubic yard.

On the morning of Aug. 29 a bulging and sliding movement began along the north slope of the dam near the west end. At 7 o'clock in the morning of this date the track which was at the top of the dry fill, elevation 101, settled vertically about 3 ft. over a length of about 200 ft., while the track at elevation 63, down the slope, showed slight indications of movement. In the afternoon of the same day a lateral displacement of 8.8 ft. had occurred on the 85-ft. contour and 5.1 ft. on the 50-ft. contour; there was no movement on the 30-foot contour. On the morning of August 30 a further settlement and bulging had occurred, giving an additional lateral movement of 3.4 feet on the 85-foot contour, 3.2 feet on the 50-foot contour, while the toe of the slope still remained undisturbed. By the morning of August 31 a still greater displacement had occurred, adding 8.6 feet to the lateral movement on the 85-foot contour, 9 feet on the 50-foot contour, while the foot of the slope was pushed out laterally 6.2 feet on the 30-foot contour. The movement continued through Sept. 1 and ceased Sept. 2. The maximum vertical settlement of the track at elevation 101 was 20 feet, extending for a distance of 750 ft. along the crest, affecting not only the hydraulic fill but the north slope of the dry fill to the south of it. The total lateral displacement along the 85-foot contour was 33.9 feet, on the 50-foot level 31.2 feet, and on the 30-foot contour 18.1 feet. The south slope of the dam remained unidsturbed. The slope of the portion of the dam which moved was originally fixed at 1 on 5, and this was authorized "because the rock is near the surface and fairly horizontal. The only thing to be provided against in this slope is the slipping of the dam material on itself."

Because of the character of the material along this portion underlying the structure there could be no question that the movement was within the dam itself, consequently test pits were not resorted to as in the case of the movement on the east part of the dam, reported a year ago. A line of wash borings with drive samples was made. These borings clearly indicated that the relative proportions of hydraulic fill and dry fill which would bring about the desired section of hydraulic fill—wedge shape, with the point down—had not been secured, but that on the contrary the hydraulic fill in section was the opposite of this. Furthermore, it was evident that provision had not been made against the slipping of the dam material on itself. As in the case of the movement on the north face of the east portion of the dam, the toe was heavily reinforced and the slope flattened to an average of about 1 on 7.67.

CULEBRA CUT EXCAVATION

The work is in charge of Lieut. Col. D. D. Gaillard, U. S. A., as division engineer.

Excavation for the canal prism during the year was confined to Culebra cut, and 12,582,124 cubic yards were removed. In addition to this, 155,376 cubic yards were excavated in changing portions of the Obispo diversion and 35,888 cubic yards outside of the canal prism for auxiliary work. The total amount of material handled by the central division, therefore, aggregated 12,773,388 cu.yd., of which 10,098,099 cubic yards were classed as rock. The estimated amount removed because of slides was 5,899,200 cubic yards. The total amount of material due to slides so far removed aggregates 22,570,200 cubic yards, or an increase of 2,304,200 cubic yards over that estimated in the last annual report. Slides and breaks increased as the cut was deepened. No treatment has proven effective for slides when once developed except that of excavating and hauling away material from the moving mass until the slide comes to rest or until the angle of repose for the particular material in motion is reached.

The predictions of the geologist in the last annual report, with reference to the Cucaracha slide, that "the end of the activity of this slide is now well in sight, however, because all loose surface stone and clay has almost slid off, exposing several large dikes and flows of basalt which would successfully maintain in place most of the remaining material," have not been realized. The bottom grade of the canal had been reached and the widening cuts had progressed satisfactorily until within approximately 60 feet of the line of the prism was reached on the east side, when on Jan. 20 the basalt rocks broke and there slid into the cut approximately 2,000,-000 cubic yards of material extending completely across the cut, topping the tracks on the 67-ft. level and completely stopping the passage of trains from the north. This slide at the close of the fiscal year covered an area of approximately 50 acres. The total amount removed thus far since July, 1905, when it began moving, is 3,859,500 cubic yards, leaving approximately 1,500,000 cubic yards still to be removed. The material on the south side of the slide is practically all clay, the middle of it consists of clay and spalls, and the north side of it rock with a mixture of clay. The clay and the clay and spalls can be easily handled by suction dredges, while the material on the north side can be handled by dipper and ladder dredges.

NAOS ISLAND BREAKWATER

As previously stated, the Naos Island Breakwater, extending from the shore at East Balboa to Naos Island—a distance of 3.29 miles— is constructed for the purpose of cutting off silt-bearing currents that would fill the excavated channel in the Pacific and make navigation of the channel more difficult by reason of cross currents. As noted in the last annual report, considerable difficulty was experienced by the method of construction then in vogue, which consisted of dumping material from a single trestle extended in advance of the dump. A plan suggested by W. G. Comber was considered by a board and adopted. The plan consists of the building of a double trestle extending to Naos Island, dumping to be done on either side, thereby spreading the fill over the treacherous bottom, and carrying it to mean tide as far as the island. When this was done, filling was to commence at the island carrying it to full height. Should the trestle fail, ample length would be left for dumping between the break and the end of the finished portion, while the broken portion was being repaired by pile drivers. On June 30, 1913, the trestle had been entirely completed and filled, with the exception of a stretch about 600 feet long. The total amount of material used for this purpose aggregated 653,242 cubic yards. The soft material was pushed out and up forming a ridge of mud, intermixed with stones that had been dumped in and carried up by the soft material, parallel to the breakwater and at a distance of approximately 100 feet from it. The total amount expended on the dike by the central division and the Pacific division up to June 30, 1913, was $384,540.89, or about $22.14 per linear foot.

The average division cost of excavation for the year, including plant charges and all items which entered into its accomplishment, was $0.5525 per cubic yard. The total amount removed from the central division since American occupation

up to the close of the fiscal year was 107,139,181 cubic yards at an average cost of $0.7105 per cubic yard. Of this total, 93,305,975 cubic yards were removed from Culebra Cut.

HYDRAULIC SLUICES

The hydraulic excavating plant at Miraflores Locks continued at work until December 1, 1912, when it was taken out of service owing to the fact that most of the remaining excavation was hard rock.

This plant was still in serviceable condition, and the suggestion was made by Assistant Engineer W. L. Thompson that at least a part of it be utilized in sluicing the soft material which was found on the north side of Gold Hill and on the top of the east bank of the Culebra Cut. The rain had cracked the bank badly and part of it had sloughed off and fallen into the cut. To the north and east of Gold Hill lies the valley of the Obispo, and the material excavated by steam shovels on this upper bench has been deposited on the dump extending almost across the valley of the river. By continuing this dump entirely across the valley and by placing culvert pipes through the dam that would result, the water could be allowed to flow through its former channel and the Obispo diversion to the Chagres River. By tilting these pipes upward on the south side of the dam they would form a spillway to any pool that the dam might make, and calculations indicated that a sufficient pool could be created to furnish water for the pumps to sluice back into the depression to the east some of the clay that would otherwise fall into the cut.

The proposition did not appeal to the officials of the central division, but after the renewed activity of Cucaracha slide it was decided to make use of the sluicing plant for this purpose. The location selected for the pumps and pipe line was such that the rear of Cucaracha Hill could be taken off and washed back into the valley to the east by the use of relay pumps and, further, whatever material remained on the cut side of Cucaracha Hill could be washed down to the dredges, thereby finishing up Cucaracha slide for good and all.

These considerations led to the adoption of this method of sluicing, and the work was placed in charge of the resident engineer of the fifth division. Work on the installation of the hydraulic pumping mains and flumes was started on Feb. 1, 1913. The dam has created a lake of approximately 180 acres, with a drainage area of 4 square miles. The elevation at the bottom of the suction at the pumping plant is 214 feet above sea level, and the elevation of the pipes forming the spillway is 228. The material is washed back into the depression which forms the lake, and discharges at such a distance from the pumping plant that the water used in sluicing is returned to the lake and used over again, thus requiring only a small inflow to keep the lake at constant elevation. Sluicing was begun on June 17, 1913, and 57,274 cubic yards were removed by this method at an average cost of $0.1835 per cu.yd. Booster pumps have been ordered, and when received operations for attacking the rear of Cucaracha Hill will be begun.

TERMINAL FACILITIES

The design and construction of the terminal facilities is in charge of H. H. Rousseau, United States Navy, as assistant to the chief engineer.

The Pacific terminals, which are being constructed by the commission, will consist of a main dry dock capable of docking any vessel that can utilize the locks, a smaller dry dock for the use of smaller craft, a plant for supplying coal and fuel oil to vessels, the necessary wharves and piers for commercial purposes, and the permanent shops for use in connection with dry docks.

The Atlantic terminals consist of wharves and piers at Cristobal, including the Cristobal mole, all of which are being constructed by the Panama Railroad at its own expense, and the main plant for supplying coal and fuel oil to vessels; the cost of the coaling plant will be divided between the commission and the Panama Railroad Co., while the commission will furnish facilities for oil.

As already noted, the larger dry dock will be able to dock a vessel 1000 feet long and will have an entrance width of 110 feet. The depth of water over the top of the blocks at mean sea level will be 35 feet, at mean high water 41.5 feet, and at mean low water 29.3 feet. This dock will rest on rock and for a considerable portion of its depth will be in solid rock. The general design of the dry docks has been worked out and the preparation of detail drawings commenced. Mitering lock gates, similar to those for the canal locks and operated in the same manner, will form the closure to the dock, and beyond the gates proper a seat for the floating caisson which will be constructed for general canal use. The dock will be flooded by means of longitudinal ducts in the side walls communicating with the dock body through grated openings in the floor along the bottom of the walls. The flow of water will be controlled by four metal "wagon-body" valves operated by suitable machinery. The time required for flooding at extreme high water is estimated at 25 minutes. The pumping plant for emptying the dock will consist of four vertical shaft centrifugal pumps driven by electric motors. The discharge from the pumps will be carried through a concrete duct entirely separate from the flooding ducts. The time required for pumping out is estimated at 2 hours and 20 minutes at mean high water. Suitable tracks for a 50-ton locomotive jib crane will be provided entirely around the dock.

The smaller dry dock will have sufficient length to dock a ship 350 feet long, a width at entrance of 71 feet, with a depth of water over the top of the keel blocks at mean sea level of 16 feet 10 inches, at mean high water of 23 feet 4 inches, and at mean low water of 11 feet 2 inches. This dock was substituted for two marine railways originally contemplated, the Navy Department having expressed a preference for such a dock and local conditions favoring it.

The coaling station on the Pacific side will be adjacent to the site of the dry dock and will be capable of handling and storing 100,000 tons of coal, with a possible increase of 50%. Subaqueous storage will be provided for 50,000 tons. The specified rate for unloading coal from vessels into the storage piles has been fixed at 250 tons per hour for each machine, and the desire is to unload two vessels at one time at the Atlantic plant, with two unloading machines to each vessel, and one vessel at the Pacific plant with two machines. The reloading capacity—that is, transferring coal from storage into collier or barge—has been fixed, after consideration of the reloading capacity of modern commercial plants in the United States, at the rate of 500 tons per hour for each machine. It is proposed to equip the Atlantic plant so that two vessels can be loaded at one time, with two machines serving each vessel, and on the Pacific side so that one vessel can be loaded with two machines.

The permanent shops proper will consist of 18 buildings for the machine, erecting, and tool shops; forge shop; steel storage shed; boiler and shipfitter shop; general storehouse; paint shop; car shop; planing mill; galvanizing plant; lumber and equipment shed; pattern storage; foundry; coke shed, boiler house; roundhouse; gas house; paint house; and sand house. In addition to an office building, there will be 9 auxiliary buildings.

A contract was made Oct. 24, 1912, for 6500 squares of reinforced-cement tile roofing for all quarter-pitched roofs of the machine shops at $10.25 per square delivered and $13.25 per square erected in place, the commission furnishing certain materials, such as sand and cement, and facilities, such as suitable buildings, power, and water. All tile is being manufactured on the Isthmus, at Paraiso.

In designing the permanent shops the principle was aimed at to reduce to a minimum the cost of repairs and renewals, without exceeding a reasonable first cost. Steel was therefore adopted for the main structural material, for which the only cost for maintenance will be repainting from time to time. The roofing, consisting of reinforced-cement tile on the quarter-pitched roofs, should last indefinitely, with practically no cost for maintenance and repairs, and presents a pleasing appearance. Such buildings as have flat reinforced concrete roofs will be waterproofed with first-quality composition roofing. There will be practically no gutters or down spouts, except for drainage of valleys, in which cases copper and similar permanent construction will be employed. Buildings which require it will be closed in with walls of hollow terra-cotta tile, plastered with cement mortar; other buildings, such as the main metal- and wood-working shops, which do not require to be closed in, will be surrounded with a concrete wall 3 feet 6 inches high, above which there will be movable metal shutters or louvers as protection against wind and rain. The pattern shop and storehouse will have a second floor consisting of a reinforced concrete slab resting on steel beams and girders incased in concrete. The lumber shed and steel-storage shed will have the first floors surfaced with cinders, sand or gravel. In the main shops the floor will consist of a concrete base covered with 3½-inch creosoted wooden blocks.

In anticipation of requirements that will develop after the completion of the canal, investigations and inspections were made during the past two years of the principal floating cranes in the United States and Canada, as well as abroad, with a view to determining the type of crane that will best meet canal requirements. The conclusion was reached that two floating cranes of the largest size would be necessary to meet the conditions that might arise in handling lock and dock gate leaves. These cranes will also be required, as regards lifting capacity, to meet the requirements of the Navy Department. On October 30, 1912, proposals were invited for

the delivery of two floating cranes of the revolving type, having a maximum lifting capacity of 250 gross tons. Award was made April 17, 1913, to the Deutsche Maschinen Fabrik, A. G., for approximately $827,550 for the two cranes, to be delivered in 580 days.

Numerous applications have been received from coal dealers for loading space for the handling of their coal in supplying vessels that will use the canal. No authority exists for leasing any land or land under water in the Canal Zone, except the act of Feb. 27, 1909, which provides for the leasing of land for agricultural purposes only. It was never intended that the Government should exercise a monopoly of the coal business on the Isthmus, but to utilize the coal stored here for the use of the Navy in maintaining uniform prices of this product to shipping. In order to encourage individuals and companies in the business of furnishing coal to vessels which use the canal, the policy has been adopted of providing storage in connection with both coaling plants for the coal piles of individuals and companies who desire to participate in the business. There will be a certain rental charge for the areas and, in addition, a real-estate tax of 1% of the value of the improvements, should any be made, and a merchandise tax of 5 cents for each 2000 pounds of coal sold. The Government will do all the handling and charges for putting the coal into storage and taking it out, charges for the use of coal barges, and other labor in connection with this service will be fixed at cost price to the Government for such service. The same policy was adopted with reference to oil. It is proposed to equip the wharf in the vicinity of the coaling station at the Pacific terminus and docks 13 and 14 at Mount Hope on the Atlantic side with fuel-oil supply and delivery mains in duplicate, together with the necessary pumps, so that the Government will be able to handle satisfactorily all fuel oil, including fuel oil of individuals and companies who may wish to participate in the fuel-oil business on the Isthmus, on the same general terms as those applying to the coal business.

GENERAL

The force employed increased steadily during the first nine months of the year, until on March 26 the number reached the highest point in the history of the canal work; on that date the effective working force was 44,733, of which 39,089 were on the pay rolls of the commission and the Panama Railroad and 5644 on the pay rolls of the contractors handling the work on the lock gates, emergency dams, and other contracts in connection with the work. The average number of American employees on the rolls of the commission during the year was 4340 and on the rolls of the Panama Railroad 870, or a total of 5110. During the same period there were 2495 separations from the service of the commission, 1010 persons employed in the United States and 1331 employed on the Isthmus, indicating that more than 57% of the gold force was changed.

The value of material received from the United States during the year was greater than for any preceding year; it amounted to $13,980,071, not including $2,535,860 paid to the McClintic-Marshall Construction Co. or the value of local purchases on the Isthmus amounting to $2,733,867. The consumption of cement decreased from 1,600,000 barrels in 1912 to 1,200,000 barrels in 1913; the total consumption to date amounted to 5,797,910 barrels. During the year all cement was purchased in sacks, of which 33,475,408 were received and 29,882,968 were returned to the United States; of those returned, 269,775 sacks were rejected, or less than 1% of those returned.

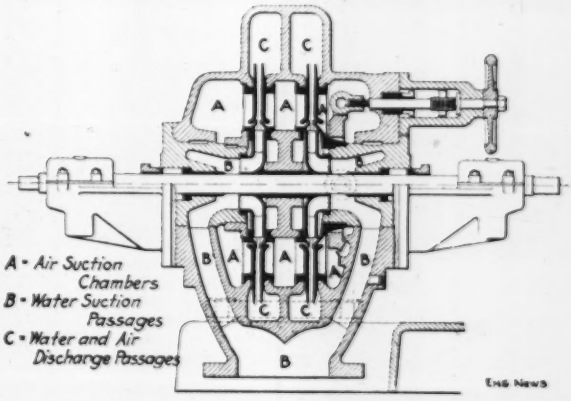
Congress has appropriated a total of $349,505,233.14 for canal construction. Of this amount, $10,676,950 were for fortifications. The balance, $338,806,861.58, including $16,265,393 appropriated by the act of June 23, 1913, was appropriated for the construction of the canal and is a charge against the total authorized bond issue of $375,200,900. This leaves available for appropriation a balance of $36,394,038.42.

It has been the general belief that the effect of the water in the cut would tend to retard slides and the experience below the Gatun locks in the sustaining power of water against slides fully justifies this belief; on the other hand, the geologist is of the opinion that the water may to some extent develop new slides. Again, much ado was made in 1909 over the seamy character of rock on the Isthmus, through which water flows quite rapidly, in consequence of which the question was raised that the lake might leak out through seams and crevices. If these things are liable to occur, the sooner the better, if the official opening of the canal is to occur January 1, 1915; for if water were not admitted this fall but were deferred until May 1, 1914, the full height could not be reached until October, 1914, leaving little time for the determination of these questions. These considerations led to the conclusion that the water should be turned into the cut at the earliest date practicable for getting the dredges to work on the slides.

GEO. W. GOETHALS,
Colonel, Corps of Engineers, U. S. A.,
Chairman and Chief Engineer.

Another Rotary High-Vacuum Air Pump*

One more addition has been made to the various designs of air pumps which we have described in the last four years, for the economical production of high vacuums needed in steam-turbine practice. This last is a high-speed rotary type, designed by Thyssen & Co., the well known power-machinery makers, of Mulheim-on-Ruhr, Germany, the American rights having been taken by the C. H. Wheeler Manufacturing Co. The pump acts on the now familiar principle of entraining rarefied air by water spouting at high velocity, this air being compressed by the water in properly shaped passages before discharge of the mixture under atmospheric pressure. The accompanying figure shows that the machine is a double-impeller single-phase centrifugal pump, with a horizontally divided case. Each impeller discharges into an annular nozzle, from which the water emerges at high velocity in a thin film. Between the two impellers is a disk, carrying two nozzle rings, the other two nozzle rings shown being separate and not rotating. One of the latter is attached to the casing and the other forms a sliding sleeve, under hand control of axial travel, varying the width of opening between the nozzle rings. It is seen that by having one half of each nozzle revolve, the water is given a tangential velocity, so that it does not shoot radially across the entrainment space; this increases the aspirating effect. The impellers automatically take up a central position under the nozzle rings, with the various adjustments of the latter, a small lateral movement of the sliding nozzle ring being immediately followed by an endwise displacement of the shaft, which brings the impellers into hydraulic balance, with the opening on the two nozzle rings of equal width. Speeds of 1000 to 3000 r.p.m. are permissible. These pumps are built in sizes up to those required by condensers for a 15,000-kw. capacity unit.



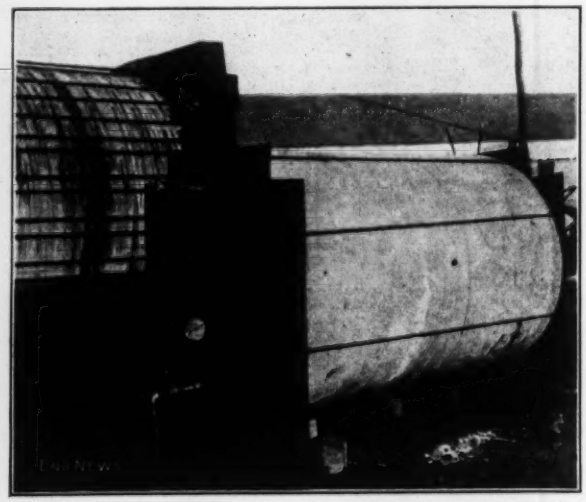
THYSSEN DESIGN OF ROTARY HIGH-VACUUM AIR PUMP

*From information furnished by the C. H. Wheeler Manufacturing Co., Philadelphia, Penn.

Pressure Tests of Jointed Concrete Pipes

Pressure tests on the water-tightness of jointed concrete pipe have been under way for some time by the Lock Joint Pipe Co., at its works at Ampere, N. J., and on Nov. 6, 1913, a demonstration was made before a number of engineers of the resistive qualities of three lines of these pipes under very severe pressure conditions. The company for some time has been manufacturing a concrete pipe in short lengths, and making the joints between the sections after the pipe is laid. Hitherto, however, all such pipes have been for gravity flow and light pressure only, and the company is now studying the development of a joint which will sustain greater pressures, with a view to using the pipe in pressure lines up to 150-ft. heads.

The "lock-joint" pipe is cast in 4-ft. lengths and is



JOINTED CONCRETE PIPE UNDER PRESSURE TEST
(48-in. pipe under 72-lb. pressure at right; 84-in. pipe at left.)

provided with a peculiar bell end, of such design as to allow a groove on the inside of the pipe at the joint. In making the final joint after the pipe is placed, the reinforcements of the adjoining pipes are overlapped in the internal groove, and the groove filled up flush with the inside of the pipe by pouring in a cement grout. The pressure pipes are of the same general type, except for a specially prepared plastered interior cover to the joint, which is described below.

In the recent tests, three separate lines of pipes were subjected to pressure, one of 63-in. diameter, one of 84-in. diameter and one of 48-in. diameter. The accompanying table gives data on the pipes.

DATA ON JOINTED CONCRETE PIPE UNDER PRESSURE TEST

Diameter in.	Thickness walls in.	Total length ft.	Length of sections ft.	No. of joints	Maximum pressure lb. sq.in.	Results
84	8	8	4	1	65	Slight leakage Bulkhead broke
63	6	16	4	3	54	No leakage
48	5	8	4	1	90	Pipe failed No leakage

Circumferential reinforcement in all pipes, ⅝-in. twisted rods. Longitudinal reinforcement near outer face in all pipe, ⅝-in. twisted rods, 24 in. c. to c. in 84-in. and 63-in. pipe, 12 in. c. to c. in 48-in. pipe; 84-in. and 63-in. pipe had in addition near inner face a layer of No. 38 Am. Steel & Wire Co. triangular mesh.

Each line of pipe was set up on blocks, the joints made from the inside, in the same manner in which they would be made in practice, the ends of the pipe bulkheaded, and the water pipes from the city mains (which have a pressure of 100 lb. per sq.in.) entered at one end. The accompanying view shows two of the pipe lines under test.

The 63-in. and 84-in. pipes were made last February, and have been under water pressure off and on since that time, with a maximum pressure at any one time of 60 lb. per sq.in. These pipes were placed under pressure when 16 days old, with a joint between the pipes the same as in the ordinary gravity flow pipes. Under a pressure of 45 lb. per sq.in. the leakage of this pipe, including the joint and the pipe, was at the rate of 12,000 gal. per mile per day, for the 84-in. pipe and 90,000 gal. per mile per day for the 63-in. pipe. The joints were then prepared according to the pressure noted below, for the test which was made on Nov. 6. At that time the pressure was carried up to 65 lb. per sq.in., at which time severe leakage in the bulkhead prevented any further pressure being put on the 84-in. pipe.

The 63-in. pipe leaked as noted above when provided with the standard joint, but a special joint was later made. With this joint it was under pressure for four days preceding this latest test, with a maximum pressure during that time of 56 lb., and an average of about 40 lb. The line was tested on Nov. 6 to 54 lb. per sq.in., and no leakage showed either through the pipe or through the joint.

The 48-in. pipe, which was provided with the pressure joint from the beginning, had been under pressure for 48 hr. previous to Nov. 6, during which time the pressure varied from 40 to 55 lb. per sq.in. On Nov. 6, the pressure in this pipe was run up to 90 lb. per sq.in., at which time failure occurred. This failure consisted in thin hairline cracks through the joint structure, and a few pinhole openings through the concrete wall of the pipe. The failure was sudden, and up to the point of breaking no leakage was discoverable. After the water was removed from the pipe, the cracks through which the leakage occurred were not easily visible to the unaided eye.

All of the pipes in this test were made in the yard at Ampere, the method of mixing and the materials used being the same in all of the sections. The mixture of concrete was 1 : 1½ : 2½, a standard portland cement, an ordinary bank sand, and ¾-in. New Jersey trap rock being used for all the work. No waterproofing of any sort was used in any of the pipe, nor was there any effort made to grade the aggregates, either fine or large. It is the opinion of the engineers of the company that the superior water-tight quality of the concrete is due to the richness of the mixture and the carefulness of mixing.

In mixing the concrete, the order of procedure is quite the reverse of that normally specified in concrete work. A small batch mixer is employed. In this is first placed the water, and then the cement, next the stone, and finally the sand, allowing a due interval between the addition of each new material for the thorough mixing of those materials already in the mixer. A fairly wet concrete is used.

As noted above, in making the joints for the pressure pipe, a specially prepared inner surface of the joint was made. Sections of the pipe were placed together with the metal overlapping in the joints. An inside metal form was then placed, and the joint was poured with ordinary cement grout; but the inner plate was so adjusted that the grouted section did not entirely fill the

opening, a shallow groove being left along the inner space of the pipe at the joint. After the joint had set and all shrinkage cracks had appeared, this shallow groove was plastered to a flush surface with the inner surface of the pipe, with a cement grout in which the cement was of a specially prepared quality. This inside collar was given a hard troweled surface, was about $\frac{3}{16}$ in. thick and extended about 3 in. on each side of the joint.

The cement used in this collar joint was of an extremely fine texture. Originally, the company prepared this cement itself by screening the standard portland cement through a sieve, so as to get a material which would pass 100% through a 200-mesh sieve. Later, however, it made arrangements with a cement mill, whereby the mill collected all the cement which settled on the rafters of the storage bin. This cement on test proved to be of very fine quality, at least as fine in granular consistency as the 200-mesh sieve cement noted above. No little of the effectiveness of the joints in the test just noted are supposed to be due to the quality of this cement. In both the 48-in. and the 63-in. pipe, tests had been made with the ordinary joint, and both pipes leaked excessively. After the inside collar with the very fine cement was applied, the leakage was, as noted above, practically nil.

The 48-in. pipe was figured for an internal pressure of 52 lb. per sq.in., allowing 10,000 lb. per sq.in. of steel. The steel in the pipe, when it cracked at 90 lb. per sq. in., was in tension of about 17,500 lb.

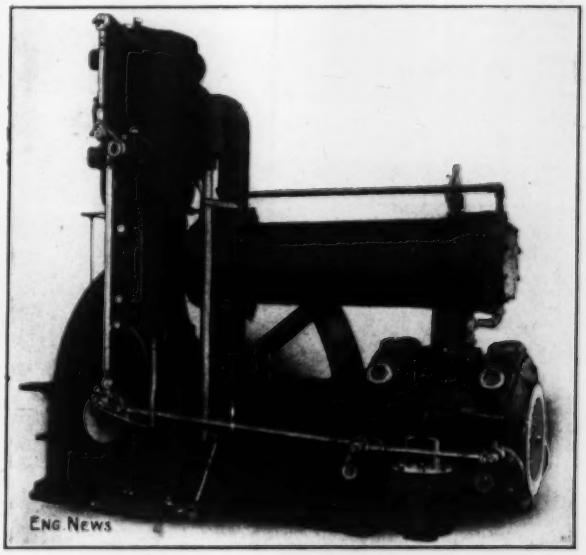
An Angle-Compound Air Compressor

A design of compound air compressor now being introduced has as its special feature the use of one horizontal and one vertical cylinder, with both pistons driven from one crankpin (on a center crank) and both sets of valve gears driven from one crank disk on the end of the shaft. This cylinder arrangement economizes materially in the floor space occupied for a given capacity and has been used extensively for large compound steam engines, and for some large air compressors, but the new compressors are said to be the first of this "angle-compound" type to be made in the ordinary commercial sizes. They are built either as direct-connected or belt-driven machines, and one of the latter is shown in the accompanying cut.

In addition to the advantages in small floor space required, mechanical advantages are claimed in regard to effective balancing and consequent steadiness of running and absence of vibration. Heavy counterweights are bolted to the crank arms to balance the reciprocating parts, and in this way the shaft practically absorbs the inertia load which would otherwise be carried by the shaft bearings while the distribution of the strains tends to cause more uniform wear of the bearings. There is also a material reduction in the number of working parts, and the foundation work is reduced considerably as compared with compressors having two horizontal cylinders.

The low-pressure cylinder is horizontal, and at the end of the main bedplate is a pedestal to which the vertical high-pressure cylinder is bolted. The bored guides for the latter are formed in this pedestal. The cylinders proper are liners fitted in the cylinder castings, the space between the liner and casting being utilized for the water jacket. The inlet valves are of the Corliss rocking type, while the discharge valves are of the poppet type, all operated from a pin in the crank disk on the end of the shaft.

The crank case is inclosed, but not on account of splash lubrication, as stream lubrication is provided for all main parts. The lower part of the bedplate forms a tank for oil, and a small plunger pump driven from the valve gear delivers the oil to an elevated reservoir, the capacity of the pump being such as to maintain a continual overflow from this reservoir to the tank. The oil flows by gravity from the reservoir to the shaft bearings, the crankpin, and the crosshead pins and guide, the flow being regulated by sight-feed connections and the oil returning to the tank.



AIR COMPRESSOR OF THE ANGLE-COMPOUND TYPE

A horizontal intercooler is placed above the low-pressure cylinder, and consists of a cast-iron shell containing two sets of aluminum tubes through which the water passes and returns between the two headers. Additional cooling is provided by passing the air around the outer walls of the cylinder jackets.

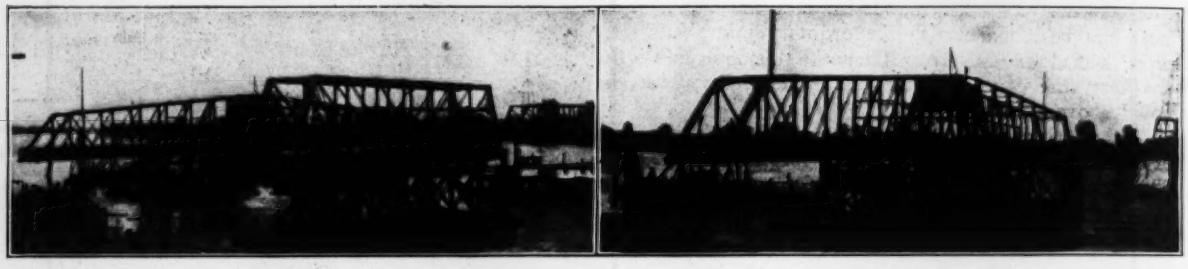
These machines are built by the Sullivan Machinery Co., of Chicago, and several are in use at quarries, mines and manufacturing plants.

Three-Hinged Skew Arches of Reinforced Concrete were built over the Berlin-Spandau canal in Berlin, Germany, two years ago. A description has just appeared in "Zeitschrift für Bauwesen" of 1913, Part X-XII. One of the bridges has a span of 157½ ft. and a rise of 16.4 ft., with a skew of 35° from square crossing (intersection angle 55°); the ring is 26 in. thick at crown, and 42 in. thick at the maximum in the haunches. The other bridge has a span of 148 ft., a rise of 14.7 ft., and a skew of 22° (intersection angle 68°). The hinges are steel castings, and the hinge lines are parallel to the abutments, i.e., parallel to the canal axis, instead of being stepped. Dowels in the hinges prevent sliding along the joint, under the slipping force due to the skew between arch thrust and hinge line. The arches were calculated as statically indeterminate structures, there being horizontal and vertical torsion moments at the crown in addition to the crown thrust. The designer, W. Nakonz, states that these moments are small and it is sufficient to calculate as for a square three-hinged arch. The bridges were built by Dyckerhoff & Widmann. These bridges showed large crown deflection on striking centers, 2¾ in. in the larger bridge and 3½ in. in the smaller, with increase of span length by about 1 in. The abutments are founded on gravel. The acute angles of the arch abutments are subjected to excess thrust in such bridges.

Transferring Bridge Spans on Barges

In the reconstruction of the Wabash R.R. bridge over the Mississippi River at Hannibal, Mo., one feature of special interest was that of changing the position of the draw span. This is a swing span with arms 180 ft. long, and it was moved 180 ft. westward from the old pivot pier to a new pier, while a fixed 180-ft. span displaced by the new position of the west arm was moved into the space previously occupied by the east arm of the drawbridge. Both spans were floated on barges from their original to their new positions. These operations were carried out successfully on Sept. 5 and 6. For information respecting this interesting piece of work we are indebted to Mr. E. H. Connor, Chief Engineer of the Missouri Valley Bridge & Iron Co., of Leavenworth, Kan., which company has the contract for the reconstruction work.

The estimated weight of the draw span is 550 tons, and of the fixed span, 270 tons. The floor of the bridge is covered with oak to form a roadway to accommodate wagon traffic, greatly increasing the weight to be carried on the barges. Traffic on both the river and railway had to be maintained with as little interruption as possible.



TRANSFERRING A DRAW SPAN AND A FIXED SPAN OF THE WABASH R.R. BRIDGE OVER THE MISSISSIPPI RIVER AT HANNIBAL, MO.

(The left-hand view shows the 180-ft. fixed span floated laterally out of place while the 360-ft. swing span is being floated 180 ft. longitudinally to its new pivot pier. The right-hand view shows the swing span being moved. Its farther end is over the old pivot pier, which is now the east rest pier. The fixed span was later floated into the space between the old pivot pier and old east rest pier.)

Four barges 24x70 ft. were placed under the draw span. Under the fixed span were two barges 22x64 ft. and one 20x100 ft. Timber towers 23 ft. high were erected on the barges, and the spans blocked on these. Owing to the fall in the river, about 6 ft. of blocking was required. The fixed span was blocked under the floor beams, as the construction of the bottom of the posts prevented the placing of blocking under them. All panel points, except the end ones, were supported in this span. The draw span was supported at four points in each truss in each arm. Several of the diagonal tension members had to be reinforced to take compression. A new center and track were placed on the new pivot pier, but the balance of the machinery was moved with the draw.

Four 6-in. siphons were used to pump out the four barges under the draw. Two centrifugal pumps and one pulsometer were used to pump out the three under the fixed span. In addition, each barge was provided with a 2-in. or 3-in. siphon to take out the last few inches of water. The 6-in. siphons were connected to the boilers on the pressure barge located above the old pivot pier, which had to be disconnected when the barges were moved. The small siphons in the barges under the draw were connected to the boiler of the draw span. The pumps under the fixed span were connected to a boi[ler] on the middle barge.

Two barges carrying hoisting engines were anchor[ed] upstream on each side of the new pivot pier. A clust[er] of piles was driven above the old east rest pier of t[he] draw. Lines of manila cable were run from the w[est] anchor barge to each barge under the fixed span a[nd] under the draw span. The barges were dropped down stream by snubbing these lines. Wire cables were ru[n] from the west anchor barge around the old pivot pier t[o] the upper ends of the barges under the east arm of th[e] draw. These lines were used to pull the draw span upstream into final position.

The barges were placed under the spans and sunk to the required level by filling them with water to within a few inches of the deck. Then the pumps were placed and connected up, the blocking placed, and everything made ready for moving. At 11 a.m., Sept. 5, the barges had been pumped out, and the spans were floating.

The fixed span was first moved downstream about 200 ft., and tied up to two clusters of piles and the west bank. After it had been moved down about 50 ft. a slight breeze sprang up from the south, and the span started sailing upstream. This was overcome by lines leading to the west bank and a steamboat. By noon this span was safely tied up.

Considerable temporary blocking had to be moved from the pier at the west end of the draw (the new pivot pier) to the east end. The wind increased, but at 3 p.m. the draw span was started, and reached its final position about 5 p.m. The new and old centers did not fit, and darkness came before the connections were made. This necessitated leaving the fixed span on its barges all night. On the morning of Sept. 6, the lines were rearranged the temporary blocking placed, and the fixed span moved to its final position. There was little clearance between the other spans, and the wind was strong, but the move was successfully accomplished, and the first trains crossed about 3:30 p.m. A boat passed through the draw a little later.

Contrary to calculations, the spans had to be pulled downstream instead of up, this being on account of the wind. Owing to the low stage of water, the current was not as swift as usual, probably about two miles per hour. The barges did not leak, and at all times the spans appeared perfectly stable.

The above views show the transfer of the spans in progress.

Civil Service Examination Questions for New York State Engineering Positions

The following questions were used in recent New York State civil service examinations for chainman, leveler, junior bridge draftsman, bridge draftsman, bridge designer, electrical draftsman, engineering draftsman and junior railway engineer, and may be of interest to our younger readers. At the head of each examination sheet were blanks wherein the competitors are called upon to state at what times, respectively, the examination was commenced and finished.

Chainman (Part 1)—Held Oct. 25, 1913

Table of logarithms will be furnished by the examiner, upon request. No reference books may be used in this examination.

1. From the ends of a base line AB, 345.7 ft. long, angles CAB = 67° 35′ and CBA = 51° 25′, and the vertical angle at B = +19° 21′, were measured to a point C. Find the distance from C to A and B, also the difference in elevation between B and C.

2. The height of a concrete wall varies uniformly from 5 to 20 ft.; its thickness at the bottom is required to be one-third the height, but nowhere less than 3 ft., and the top width is constant or uniform at 2 ft. The total length is 40 ft., and the cross-section is trapezoidal throughout. Make a sketch of the wall described and compute its volume in cubic yards.

3. The distance between two points A and B on a given straight line is 13 ft.; find the radius of a circle which shall be tangent to the given line at A and also tangent to a circle of 9 ft. radius, whose center is 15 ft. from B on the perpendicular drawn through B to the given line.

4. If 25 men, paid $1.75 per day under a foreman whose salary is $80 per month, dig 1850 cu.yd. in 21 days, how much more or less will it cost per cubic yard if 12 men, paid $1.90 per day under a foreman paid $70 per month, dig 190 cu.yd. in three days?

5. A trench 6 ft. wide and 12 ft. deep is sheathed by 2-in. planks, supported by two rows of 8x8-in. longitudinal rangers, which are held apart by 6x8-in. transverse braces spaced 6 ft. center to center. How many feet, board measure, are required per lineal foot of trench? Make a sketch of the sheathing and bracing described.

PART II

Answer five questions.

1. Given the following description of the boundaries of a lot: Beginning at a point 50 ft. due east of a monument forming the northeast corner of the lands of John Doe, thence running N 27° 35′ E, 342.7 ft.; thence N 71° 20′ W, 45 ft. to the lands of Richard Roe; thence along the lands of Richard Roe, N 30° 55′ E, 133.5 ft. to an oak tree; thence S 62° 15′ E, 84.5 ft. to a stone monument; thence S 87° 35′ W, 933.7 ft. to the place of beginning. Plot this area to a scale of 100 ft. = 1 in., using natural tangents to lay out the angles.

2. Describe how, given the above description, a resurvey of the lines would be made. [illegible]ould be done if the measured distances or angles did not agree with the marks or boundaries found on the ground?

3. To what causes may inaccurate tape measurements be due? Explain how each may be eliminated, compensated or corrected.

4. Explain, by showing a set of notes, the method of finding the elevation of a point, say 50 ft. down hill from a bench mark or point of known elevation.

5. Describe the working of a common form of machine concrete mixer. Describe how concrete should be mixed by hand.

6. Explain how the quantity of material taken from a broad, shallow borrow pit would be measured.

7. Describe and give the use of each of the following: (a) profile; (b) slide rule (c) planimeter; (d) stadia; (e) vernier.

Leveler (Part I) —Held Oct. 25, 1913

The examination consists of two parts, of which the first counts 60, and the second 40. Books or other references may be used with the first part. If the statement of conditions of any problem seems inadequate, competitors may assume further data not inconsistent with that given. The time allowed for the whole examination is eight hours.

Answer four problems.

1. It is required to compute the bearing of a line AB, whose length 358.72 ft. is measured. Readings are taken upon the points A and B from the ends of a line CD, whose bearing, N 45° 25′ 15″ E, is known, the angles DCB, 31° 45′ 10″; DCA, 72° 18′ 40″; CDA, 47° 53′ 35″, and CDB, 97° 12′ 45″, are read.

2. Find the stresses in all the members of a triangular truss under a gable roof of 50 ft. span and 12 ft. rise or depth at the center. The lower chord is horizontal and divided into five equal panels. The trussing is a single triangular or Warren system. Assume a vertical dead load of 1500 lb. per linear ft.

3. Design a reinforced-concrete beam of 15 ft. span to carry a uniform load of 500 lb. per linear ft., with the most economical use of material. The allowed stress on concrete is 650 lb. per sq.in.; allowed stress on steel is 18,000 lb. per sq.in.; modulus of elasticity of concrete is 2,200,000; modulus of elasticity of steel is 28,000,000.

4. A cantilevered sidewalk bracket on a bridge consists of a web plate $\frac{7}{16}$ in. thick, varying in depth uniformly from 15 in. at the outer end to 3 ft. 6 in. at the inner end, an upper (horizontal) flange of 2 angles, 3½x3x½ in., and a lower flange of two angles, 4x3x$\frac{7}{16}$ in. The width of sidewalk, or length of bracket, is 12 ft.; the live load is 1200 lb. per lin.ft. Compute the maximum stresses in this bracket.

5. The cost of pumping at a water-supply station is $0.12 per i.hp.-hour. The plant supplies 10,000,000 gal. per day to a reservoir 8500 ft. distant, at an elevation of 180 ft. above the pumps. A 30-in. pipe line from pumping station to reservoir costs $70,000, and a 36-in. line, $100,000. Assuming that interest, depreciation, etc., of the pumping mains may be taken at 7% of the cost, find which of the two lines would prove more economical, considering annual cost of power and pipe line, assuming average values for losses, etc.

6. The forebay of a power house consists of a rectangular concrete trough, 30 ft. wide by 8 ft. deep, built on a grade of 1 in 1500. Find the depth of a canal of the same bottom width, built on a grade of 1 in 1000, with earth bottom and sodded banks standing at a slope of 1 on 2, that will have the same capacity as the concrete section.

7. A railway curve of 3°20′ extending from the P. C. at sta. 722 + 21.6 to the P. T. at 731 + 89 is intersected at sta. 726 + 45.2 by a second line built on a 2° 10′ curve, beginning at sta. 52 + 41 (on the second line) and extending to sta. 65 + 22.4, the intersection on this line being at sta. 56 + 20.5. If the curve on the first line is changed to a 1° 50′ radius, at what sta. on each line will the new intersection come?

The stationing on both lines increases in the same general direction; the angle of intersection between the 3° 20′ and the 2° 10′ curve is 48° 36′; and the centers of the curves are on the same side of the tangent at the intersection.

PART II

Books of references are not allowed.

Answer four questions.

8. A concrete covered reservoir, 50 ft. wide by 80 ft. long, is to be built covering the whole area of a corner city lot. The excavation is ordinary earth and 15 ft. deep. The roof is to be supported by posts set 12 ft. c. to c. Show by sketch and description how lines and grades for the building of this reservoir would be given, from the time of breaking ground, to its completion. What notes or records should be made by the engineer in charge of the construction?

9. What items or points should be covered in a specification for the removal of old buildings and the excavation for the above mentioned reservoir? To what matters should an inspector on the construction of such a reservoir give attention as the work proceeds?

10. Describe several methods of determining the bearing power of the foundation of a high building, giving their relative merits and cost. Describe two methods of waterproofing the walls and floor of a building.

11. What types of excavating machinery are adapted to subway excavation, carried on in an open cut and through clay and rock, partly below ground-water level? Describe the operation of the machinery mentioned.

12. Describe several methods of draining the foundation of a highway, built on a bed of clay. Describe the equipment and method used in resurfacing a bituminous macadam road.

13. What defects as delivered on the ground, or other causes, should cause the rejection of (1) posts and plank for guard rail on highways; (2) railroad ties; (3) wooden sheet piling; (4) fabricated structural steel; (5) steel reinforcement for concrete; (6) cast-iron pipe; (7) vitrified pipe; (8) crushed stone for concrete; (9) gravel for top course of highways; (10) paint for structural steel?

Junior Bridge Draftsman (Part I)—Held Oct. 25, 1913

Answer Nos. 3-4-5 and two other problems in Part I. Use of handbooks allowed in both parts. Pencil drawings are allowed.

1. A building front is carried on two posts, spaced 25 ft. apart, spanned by a plate girder made up of a web plate,

36x⅝ in., four flange angles, 6x4x¾ in., and four flange plates two 10x⅝ in. and two 10x½ in. If the load on this girder is uniform and 3 tons per linear foot, find the maximum stress in the girder.

2. Compute the section of a post required to carry the above mentioned girder, assuming that it is 20 ft. long, and that the girder rests upon it.

3-4-5. Make a detailed shop drawing (scale, 1 in. = 1 ft.) of the girder of problem No. 1, assuming it to rest upon cap plates on the posts.

6. Make a detailed shop drawing (scale, 1 in. = 1 ft.) of the post of problem No. 2, assuming the girder to be framed into it, and the post to continue up through the building. Assume that the post is a box section made up of two 15-in. 33-lb. channels and two plates 15x½-in. section. The column is to rest upon a concrete pier.

PART II

7. A rolled-steel I-beam, consisting of a web 27 in. deep and ½ in. thick, has flanges, equal on both sides, 6 in. wide and ¾ in. thick. Compute the load that this beam could safely carry on a 20-ft. span, assuming it concentrated at a point 7 ft. from one end. Let 16,000 lb. per sq.in. be the maximum allowed stress.

8-9. The sidewalk of a bridge is supported on triangular brackets consisting of a horizontal piece whose length is 8 ft. 6 in. (the width of the sidewalk); a vertical, 3 ft. 6 in. long, attached to the bridge; and a diagonal extending from the bottom of the vertical to the outer end of the horizontal. Assuming that the vertical is a 3½x3½x⅜-in. angle, the horizontal an 8-in., 11.25-lb. channel, and the diagonal, a 4x3x½-in. angle, make a shop drawing of the bracket, assuming it attached to the side of a post.

10. Make a bill of material for the above described bracket, computing its weight as closely as possible. Include all rivet heads and gusset plates. Assume that steel weighs 480 lb. per cu.ft.

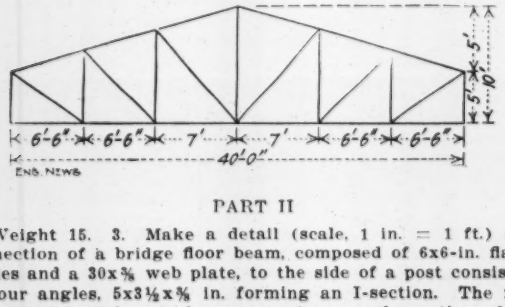
11. The height of a concrete wall varies uniformly from 5 ft. to 18 ft.; its thickness at the bottom at every point is required to be four-tenths the height, but nowhere less than 2 ft. 6 in., and the top width is constant or uniform at 2 ft. The total length is 35 ft., and the cross-section is trapezoidal throughout. Make a detailed drawing (scale of ¼ in. = 1 ft.) of the wall described, and compute its cost at $6.35 per cu.yd.

12. What is meant by (a) grip of rivets; (b) double shear; (c) countersunk rivets; (d) eccentric connection; (e) camber?

Held June 14, 1913

Weight 25. 1. A wooden tower 10x10 ft. by 35 ft. high, made of four 8x8-in. corner posts and 3x8-in. bracing, is to have on top, a working platform made of 2-in. planks, 15x20 ft., carrying a uniform load of 200 lb. per sq.ft. Compute the stresses in the platform and posts. Sketch an arrangement of joists and flooring for the platform and draw to the scale of ¼ in. = 1 ft. a detail of the side elevation of the tower.

Weight 35. 2. Make a shop detail (scale, ¾ in. = 1 ft.) of half of the roof truss outlined in the accompanying sketch. Assume that it is to rest on brick side walls. All members consist of 3½x3x⅜-in. angles.



PART II

Weight 15. 3. Make a detail (scale, 1 in. = 1 ft.) of a connection of a bridge floor beam, composed of 6x6-in. flange angles and a 30x⅜ web plate, to the side of a post consisting of four angles, 5x3½x⅝ in. forming an I-section. The floor beam may be taken to have a maximum end reaction of 90,000 lb.

Weight 15. 4. Draw (scale, ¼ in. = 1 ft.) a detail of a front elevation and a section through the middle of a straight, plain concrete bridge abutment 12 ft. high, built on and backed by dry sand.

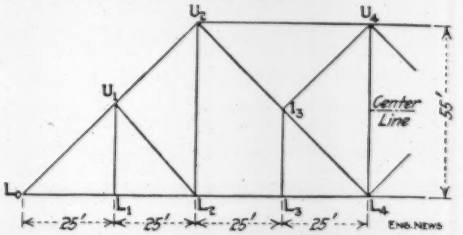
Weight 10. 5. What considerations or points should a draftsman keep in mind in spacing rivets in the flanges and cover plates of plate girders? Why are field rivets not reckoned as of the same value as shop rivets? What is meant by radius of gyration, neutral axes, camber?

Bridge Draftsman (Part I)—Held Sept. 13, 1913

Answer five questions of Part I.

Carnegie, Cambria or similar handbooks may be used. If no other reference books are allowed.

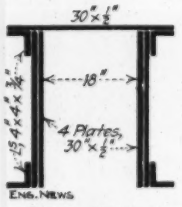
Answer four questions of Part II.



1. Compute the maximum stresses in all the members shown of the above truss, due to a moving uniform load of 8000 lb. per linear ft., on each truss, neglecting dead load or impact.

2. The above truss is to have riveted connections. Design sections for $U_2 U_4$, $L_0 L_2$ and $U_1 L_2$.

3-5. Make a complete shop detail (scale, 1 in. = 1 ft.) of the chord $U_2 U_4$ of the above truss. (If 1 and 2 are not answered assume the accompanying section:



6. A highway bridge over a railroad has a span of 33 ft. in the clear. The roadway carries a live load of 300 lb. per sq.ft., and is 26 ft. wide. It is to be supported by three reinforced-concrete beams. Compare the cost of such a design, with a similar design in which the beams are supported at their centers by a wall between the two tracks, 12 in. thick. The clearance is to be 21 ft. from the top of rail.

7. A stringer of a railroad bridge is 30 ft. long and built up as follows: Four 6x6x⅞-in. angles, one web plate 42x⅜ in., 6x6x½-in. connection angles, having fifteen ⅞-in. rivets connecting them to the web of the floor beam. What uniform load can the stringer carry at 10,000 lb. for shear and 16,000 lb. for flexure? Do rivets, web, or flange determine the load?

PART II

8. A reinforced concrete column of section 20x20 in., reinforced with four 1½-in. round rods, supports a direct load of 300,000 lb., and an eccentric load of 30,000 lb. acting at a distance of 20 in. from the center line of the column. Determine the maximum unit stress in the concrete.

9. Design a rectangular reinforced concrete footing to support two reinforced concrete columns, 15 ft. c. to c., One column carries a load of 200,000 lb., the other 340,000 lb. The former has a cross-section of 20x20, and the footing cannot extend beyond the outside face of this column. Allowable soil pressure 5000 lb. per sq.ft.

10. Two tangents make an angle of 50° with each other and are connected by a 5° curve. A street 40 ft. wide crosses one of them 250 ft. from their intersection. What will be the skew span of a bridge over the street where the 5° curve crosses it?

11. Describe in detail the erection of a two-track plate-girder bridge having a floor of transverse I-beams.

12. Describe the work of a steel inspector, following the steel from the mills until it is ready to leave the shop.

13. What are the general specifications for members subject to reversal of stress? Explain by diagrams the difference between double shear and bearing. Define effective depth and equivalent flange area. Give the distance of the gage lines from the back of the angles for 3 in. to 8 in. legs, inclusive.

Bridge Designer (Part I)—Held July 26, 1913

Part I counts as two-thirds of total.
Part II counts as one-third of total.

1. It is required to remove a post in a building as indicated on Fig. 1 [top of p. 1131]. The load is to be carried entirely by an offset post framed into the original column above and below, the new work to be confined to the adjoining stories of the heights indicated. Given that the post carries a load of 250,000 lb.; show a detailed design for the alteration, computing stresses throughout, and explaining how the work would be handled.

2. Work up a stress sheet with sections of one arm of the swing bridge of Fig. 2, considering it to act as a simple span when closed, and subject to loads of 50,000 and 35,000 lb., respectively, on axles 8 ft. apart, followed by a uniform load of 2500 lb. per linear ft.

3. Make a detailed design of a concrete retaining wall, of the general outline of Fig. 3, given that it is reinforced with 3x3x⅝-in. angles, backed by and rests upon a mixed clay and gravel whose angle of repose is 20° with the horizontal.

PART II

4. Suppose a railroad contemplates increasing the loading on an old truss bridge, say 15%; what investigation should be made to determine whether changes or replacement is required?

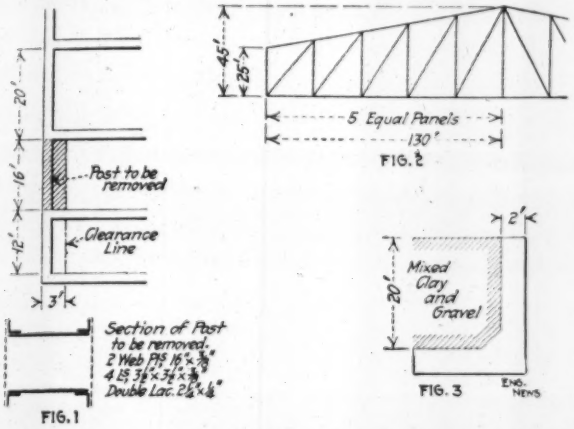


FIG. 1 FIG. 2 FIG. 3

5. Give two forms of impact formulas in common use. What fixes the upper limit to the allowance for this effect? What members of a bridge are most subject to fatigue? How is this usually cared for in specifications?

6. Describe the work of an inspector in a bridge shop, detailed to look after the manufacture of a swing bridge.

7. Explain how changes in the quality or characteristics of the materials may affect the position of the neutral axis in a reinforced-concrete beam. Give a method for determining the amount and disposition of shear reinforcement in a concrete beam.

8. Give the essential ingredients of a paint for structural material. Under what conditions are the following coatings particularly useful. Asphaltum; red lead; cement; graphite?

Electrical Draftsman (Part I)—Held July 26, 1913

Answer five questions in each part.

1. Sketch and explain the methods you consider best for bringing electric-light feeders into buildings from overhead and underground distribution systems and connecting them to interior wiring systems.

2. Describe the various interior wiring systems used and state the advantages and disadvantages of each.

3. Describe the various methods of running wires in buildings and state under what conditions each method is used.

4. What determines the size of the conductor used for lighting circuits? Give and explain formulas you would use for calculating the size of conductors.

5. Sketch and explain the construction of a 12-circuit panel box (a) for a two-wire, 110-volt, direct-current system; (b) for a three-wire, 220-volt, alternating-current system.

6. Draw a section of an office building of five stories and a basement, showing the layout of feeders, with one panel box per floor, and the main switchboard in the basement.

PART II

7. Sketch a plan of the engine room for an isolated power plant consisting of one 220-volt, 50-kw., three-wire, direct-current engine-driven generator and auxiliary apparatus. Sketch the foundation for the engine and generator. Of what material would you construct this foundation? Describe the generator switchboard you would use for this plant and make a sketch of the front of the board showing the location of the instruments, protective apparatus and switches. Make a type diagram of the electrical connections between the generator and the switchboard busbars. Calculate the current-carrying capacity of the generator switch.

8. Make a type diagram of the electrical connections for a 10-hp., 220-volt, direct-current motor including switches, and protective apparatus. Calculate the current-carrying capacity of the switch.

9. Sketch the engine room of a steam-turbine power plant consisting of three 2000-kv.a., two-phase, 2300-volt turbo-generators; two 110-volt, 100-kw., direct-connected exciters, and auxiliary apparatus. Sketch the front of the generator and exciter switchboards. Make a type diagram of the electrical connections between one alternating-current generator and the switchboard busbars. Calculate the current-carrying capacity of this generator switch.

10. Make a sketch of a 2300-volt alternating-current, four-pole, single throw, hand-operated oil switch and explain its operation.

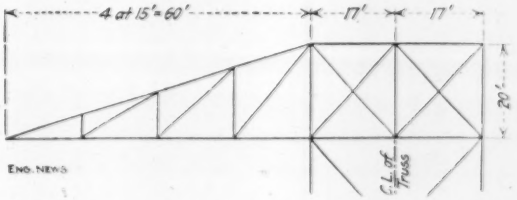
11. Make sketches of the various lightning arresters used; explain their construction and show how they are attached to the circuits they are to protect.

12. Make a sketch and explain the construction of a water-tube steam boiler.

Engineering Draftsman (Part I)—Held July 26, 1913

Answer four questions in each part.

1. Compute the maximum stresses in each member of the



truss shown, due to two moving loads of 20,000 lb. each, on axles 8 ft. apart.

2-3. Make a complete design of the section of a horse-shoe reinforced-concrete sewer, laid on a 0.6% grade and designed to carry a maximum flood discharge of 500 cu.ft. per sec. The sewer is to be built with its invert 15 ft. below the surface of the street, the street load carring 600 lb. per sq.ft. The material above and below the invert consists of loose wet gravel. Draw a detail of the cross-section of the sewer (scale, ½ in. = 1 ft.).

4-5. Design a section for a plain concrete dam (not an overflow dam or weir) 50 ft. high, resting on a rock foundation, the dam to be built on a stream in northern New York. Make a detailed drawing of a spillway section for the dam (scale, ¼ in. = 1 ft.). Show a gate house at the lower end of a 48-in. pipe line through the dam.

6. Given that the dam of question 4-5 is curved to a radius of 300 ft. and built in a valley whose side slopes make an angle of 35° with the horizontal, compute the amount of concrete necessary to construct it, if the width of the valley at the base is 110 ft.

PART II

7. In open channels what factors affect the discharge of streams? Give several methods of determining the flow in such channels.

8. Make a sketch of the centering for a concrete arch, showing the construction and method of removing. The arch is elliptical, 30-ft. span and 8-ft. rise.

9. What is diagonal tension in reinforced concrete? What provision for it should be made in design?

10. Describe the construction and operation of two different kinds of dredges. Describe the method of making joints in cast-iron pipe lines.

11. A five-sided field ABCDE has four of its sides described as follows: AB—N 22° 14′, E, 260.4 ft.; BC—N 81° 27′, E, 410.8 ft.; CD—S 10° 46′, 308.7 ft.; DE—S 41° 54′ W, 162.7 ft. Find the length and bearing of the side EA.

12. What are the usual specification requirements for the following: Round piles; cut stone for bridge piers; reinforcing rods; cement; sewer brick?

Junior Railway Engineer for N. Y. Public Service Commission (Part I)—Held Oct. 25, 1913

1. Enumerate the equipment that you would install in a steam-electric power station built for a peak load of 10,000 kw. and a 60% load factor, generating three-phase, 25-cycle, alternating current at 11,000 volts. Explain the reasons for the selection of the equipment named, and sketch a plan of its arrangement.

2. Suppose the transmission line from the above named power station is 30 mi. long, the power factor is 0.85 and the allowed line drop 3%; show how the computation of size of wire would be made, writing the necessary equations.

Given a single track electric railway 2 mi. long, with four cars on the line, which the schedule keeps at a constant time interval apart, in each direction. Feeders are tapped in at every half mile, and the source of power is at one end of the line. What additional data are needed to compute the size of feeders required for a given maximum allowed voltage drop at any point? Show how such a computation woulud be made, writing the necessary equations.

3. Make a diagram of the connections from the incoming three-phase alternating-current high-tension feeders, through transformers and rotaries, to the outgoing direct-current feeders to a railway circuit.

4. Describe several types of duct used for conduit carry-

ing electric wires, giving their respective merits. Show by sketch how cables should be carried through a manhole, containing both high- and low-tension lines.

5. Show by sketch and text the construction of the truck of a trolley car. What part of the running gear needs most attention and why?

PART II

6. Explain the operation of the air brake as used on subway trains. Why is not the same system used on single cars? Describe a quick takeup hand brake.

7. What types of rail joint and bond are in common use on electric street railways? Give the merits and comparative cost of each.

8. What characteristics or qualities determine the value of a lamp for street illumination and how are these qualities measured? Describe how in series-arc lighting the extinguishing of one lamp is prevented from affecting the others on that circuit?

9. Describe the method of calibrating or standardizing a consumer's direct-current wattmeter? What are usually the points which require adjustment or attention?

10. (a) What is meant by amortization? (b) By going value? (c) Describe briefly two methods of estimating depreciation. (d) Explain how the value of a franchise might be estimated.

Accidents to Passenger Trains in Great Britain

In our issue of Oct. 2 we compared the statistics of casualties in railway travel in Great Britain and in the United States and showed that, taking the number of passengers carried as a basis, the risk of life in British railway travel is less than one-fourteenth that on the average railway in this country.

It is true that the remarkable record of safe railway operation in Great Britain has this year been marred by several very serious accidents, so that the 1913 record will probably make the worst showing for many years. That this year's record is wholly exceptional, the statistics for previous years prove.

For the benefit of those who desire to study the British record in more detail, we reprint from the *London Times* of Oct. 22, the following table, compiled from the Board of Trade returns, summarizing the accidents to railway passenger trains in Great Britain and Ireland during the decade from 1903 to 1912 inclusive.

Year	Collisions.	Derailments.	Buffer-stop collisions.	Total train accidents.	Passengers killed.	Passengers injured.	Inquiries held.	Train accidents fatal to passengers.
1903	78	61	33	172	25	769	31	3
1904	83	54	27	164	6	534	29	2
1905	66	55	21	142	39	396	24	4
1906	77	75	22	174	56	631	35	5
1907	118	106	42	266	18	534	29	6
1903-1907	422	351	145	918	144	2864	148	20
1908	121	94	35	250	..	283	22	..
1909	119	78	45	242	1	390	21	1
1910	88	61	36	185	23	1111	20	4
1911	87	73	38	198	14	468	23	3
1912	90	63	33	186	20	683	24	4
1908-1912	505	369	187	1061	58	2935	110	12

It is of interest also to examine the causes of train accidents in Great Britain. The statistics of the accidents as a whole do not classify the causes; but such classification is possible concerning all those accidents of which an investigation was made by the Board's experts. This includes, we understand, all accidents involving fatalities to passengers. The following table, compiled by the *Times*, shows the causes of all accidents investigated by the Board's experts during the ten-year period ending Jan. 1, 1913.

	1903	1904	1905	1906	1907	1903-7	1908	1909	1910	1911	1912	
Collisions:—												
Over-run signals	2	3	8	5	7	25	4	5	4	3	6	
Some other fault of driver	5	1	1	1	5	13	2	3	1	4		
Irregular block working	10	13	4	8	6	41	1	2	7	6	4	
Some other fault of signalman	3	2	2	..	1	8	4	3	2	4	..	
Failure of signals	2	1	1	1	1	6	..	1	..	..	1	
Miscellaneous	..	1	..	6	4	11	2	..	1	2	2	
Derailments:—												
Defect of locomotive or equipment	1	..	1	3	1	6	2	1	2	3	1	
Defect of permanent way	..	..	2	6	1	9	3	2	2	..	1	
Excessive or unsuitable speed	3	5	2	1	1	12	1	2	..	..	4	
Miscellaneous	2	..	1	..	1	..	..	..	..	..	..	
Buffer-stop collisions	3	3	2	3	..	11	1	1	1	1	4	
Boiler explosions	..	..	..	1	1	.2	..	1	..	..	1	
Fires in trains	..	..	..	..	..	..	2	..	..	..	..	
Totals	31	29	24	35	29	148	22	21	20	23	21	190

It is not possible to make direct comparison between these British statistics and the train-accident statistics of the United States, since accidents to passenger trains are not separately classified in this country. It is at least worth noting, however, that in the year ending June 30, 1912, there occurred upon the railways of the United States to railway trains of all classes, 5483 collisions and 8215 derailments, in which 139 passengers were killed and 9391 were injured.

Imhoff Sewage Tank and Proposed Sewage Farm for Torrance, Calif.

By Ralph Bennett*

An Imhoff tank was put in use early in 1913 to treat the sewage of the new industrial city of Torrance, Calif. (described by the writer in Engineering News, of Oct. 30, 1913).

The sewage comes to the tank through an 18-in. outfall sewer, and eventually the tank effluent will be pumped to a sewage farm. Space has been reserved for three more tanks, for four sludge beds, and also for trickling or percolating filters, should the latter be required.

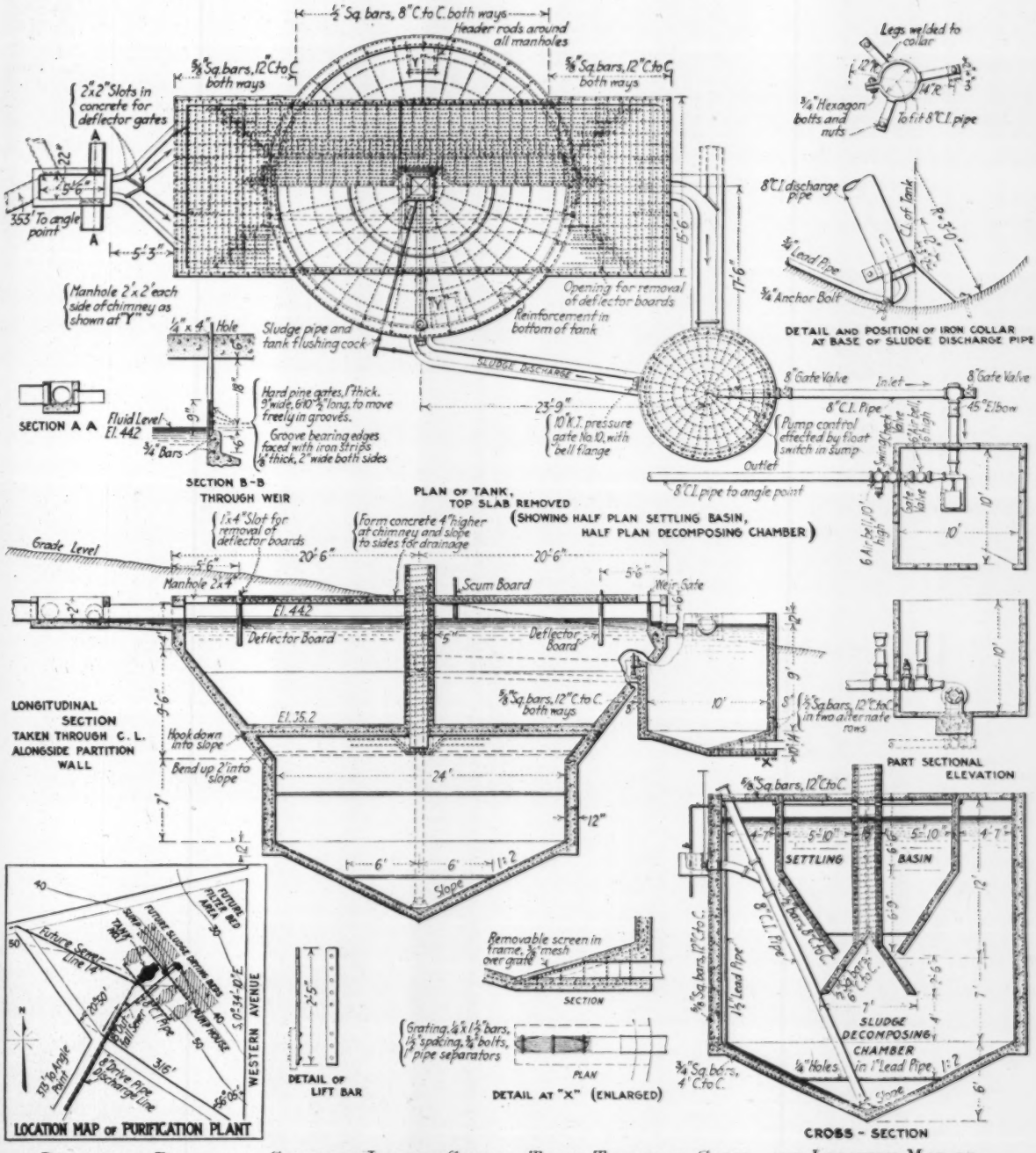
The Imhoff tank is 24 ft. in diameter and 27 ft. deep, reinforced for both internal and external pressure. The settling basin or chamber has a holding capacity of 4170 cu.ft., or about 32,000 gal., and the sludge decomposing chamber of 4500 cu.ft., or about 35,000 gal. It is assumed that this tank will serve 2500 people, with a daily per capita sewage flow of 75 gal. (187,500 gal. per day). Assuming further an hourly flow $^1/_{18}$ of the daily flow, the detention period in the settling chamber would be about three hours.

The design of the tank is shown in detail by the accompanying group of illustrations. There is a surface bypass for conveying floating materials from the inlet to the decomposing chamber.

The tank effluent is discharged through a short length of pipe into a gathering chamber or pump well, connected with a float-controlled electrically driven pump. This pump forces the effluent to a sewage farm 7000 ft. distant. The total lift is 40 ft.

Until sludge beds are provided, the sludge from the Imhoff tank can be pumped to the sewage farm or discharged by gravity into wagon tanks for disposal at some nearer point.

*Consulting Engineer, 625 South Hill St., Los Angeles, Calif.


½" Sq. bars, 8" C to C. both ways
Header rods around all manholes
⅝" Sq. bars, 12" C to C both ways
2"x2" Slots in concrete for deflector gates
353° To angle point
Manhole 2'x2' each side of chimney as shown at "Y"
Opening for removal of deflector boards
Reinforcement in bottom of tank
Sludge pipe and tank flushing cock
¼" x 4" Hole
SLUDGE DISCHARGE
Hard pine gates, 1" thick, 2" wide, 6'10" long, to move freely in grooves.
Groove bearing edges faced with iron strips ⅛" thick, 2" wide both sides
¾" Bars
SECTION A A
Fluid Level El. 442
SECTION B-B THROUGH WEIR
10" K.I. pressure gate No. 10, with bell flange
8" Gate Valve
Inlet
8" C.I. Pipe
45° Elbow
Pump control effected by float switch in Sump
Outlet
8" C.I. pipe to angle point
Legs welded to collar
¾" Hexagon bolts and nuts
To fit 8" C.I. pipe
8" C.I. discharge pipe
¾" Lead Pipe
¾" Anchor Bolt
C.L. of Tank
DETAIL AND POSITION OF IRON COLLAR AT BASE OF SLUDGE DISCHARGE PIPE
PLAN OF TANK, TOP SLAB REMOVED (SHOWING HALF PLAN SETTLING BASIN, HALF PLAN DECOMPOSING CHAMBER)
1x4" Slot for removal of deflector boards
Form concrete 4" higher at chimney and slope to sides for drainage
Grade Level
Manhole 2'x4'
Scum Board
Weir Gate
El. 442
Deflector Board
⅝" Sq. bars, 12" C to C. both ways
El. 35.2
Hook down into slope
Bend up 2' into slope
Slope
LONGITUDINAL SECTION TAKEN THROUGH C. L. ALONGSIDE PARTITION WALL
½" Sq. bars, 12" C to C. in two alternate rows
PART SECTIONAL ELEVATION
SETTLING BASIN
SLUDGE DECOMPOSING CHAMBER
¾" Holes in 1" Lead Pipe, 1:2
CROSS - SECTION
Removable screen in frame, ½" mesh over grate
SECTION
Grating, ¼" x 1½" bars, ½" spacing, ⅝" bolts, pipe separators
PLAN
DETAIL AT "X" (ENLARGED)
DETAIL OF LIFT BAR
Future Screen
Future Sludge Drying Beds
Future Filter Area
Tank No. 1
Pump House
8" Drive Pipe Discharge Line
WESTERN AVENUE
LOCATION MAP OF PURIFICATION PLANT

DETAILS OF REINFORCED-CONCRETE IMHOFF SEWAGE TANK, TORRANCE, CALIF., AND LOCATION MAP OF PRESENT AND PROPOSED TREATMENT WORKS

The tank was put in operation about May 1, 1913. After five months of use the effluent was clear and without a milky appearance. There was no scum in the through-flow or settling chamber, and only a light scum on the top of the decomposing chamber. The sewage flow had probably not averaged more than 40,000 gal. a day, on account of which one side of the settling chamber had been blocked off. No sludge measurement had been made nor had the tank been emptied.

There has been reserved for the sewage farm an area of 40 acres. Its soil is light, sandy loam, which, it is expected, will be able to take the tank effluent at a rapid rate but on account of noncompletion of the outfall to the farm no tests have been made.

The plant was designed by the writer, as chief engineer for the Dominguez Land Co., which has been building the City of Torrance.

The Largest Shipment of Radium Ore ever sent from the United States, left on Nov. 22, for France, on the steamship "Chicago" of the French Line. The 150 tons of ore shipped are expected to yield 11 grams of radium.

Heaving of Wood-Block Pavement under Extreme Climatic Conditions

A remarkable instance of the heaving of a wood-block pavement due to the excessive absorption of the blocks after a prolonged rainfall at the end of a very dry summer is reported from Longview, Texas. Below are given the reports of the resident engineer on the work and of a member of the engineering firm which had charge of the specifications for and the laying of the pavement.

REPORT ON WOOD-BLOCK PAVING, LONGVIEW, TEX.
BY H. N. ROBERTS*

During the fall of 1911 the city of Longview, Tex., laid on Tyler Ave., Fredonia St. and an L-shaped alley,

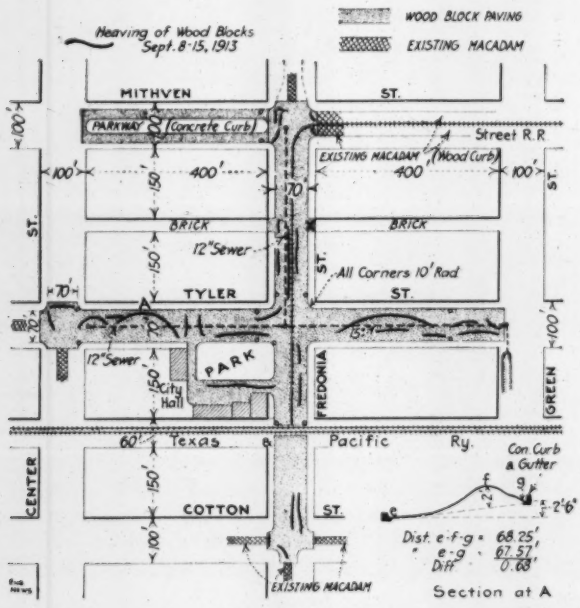


FIG. 1. PORTION OF LONGVIEW, TEX., SHOWING LOCATION OF HEAVING ON WOOD-BLOCK PAVEMENT

some 16,000 sq.yd. of wood-block pavement, which has recently been the source of considerable trouble because of the peculiar conditions, climatic and otherwise, to which this work has been subjected.

Great care was taken in the preparation of the specifications, and a very rigid inspection of the blocks and carrying out of the specifications was maintained, both at the factory and on the street where they were laid. The causes of their peculiar behavior cannot be ascribed to any one particular factor, but to a series of combined circumstances, anyone of which, by itself, would not have been sufficient to produce the ensuing results, but whose combined effect can be seen from an examination of the accompanying views.

The blocks were laid on a 5-in. 1:3:6 concrete foundation, with a 2-in. expansion joint on each side of the roadway and a 1-in. sand cushion. A coarse sand was specified for this cushion, but upon investigation it was found that a sand of such description could not have been secured without going to a considerable expense; the contractor was then allowed to use a very fine local sand, and to assume the entire risk. Only in this particular was any divergence allowed from the letter or the spirit of the specifications.

The blocks were laid close, driving having been resorted to at intervals, and on top of the finished pavement was placed a protective layer of sand, which, it is understood, was removed after four or five days, exposing the blocks to the rigor of the hot Southern sun.

The streets on which the blocks were laid were then put into service and continued under traffic without appreciable damage for two years. In the Summer and Fall of 1913, however, certain climatic conditions combined to cause serious damage to the pavement.

The summer was an exceedingly hot and dry one. For 65 days prior to Sept. 7 there was no rain, and the thermometer for days registered a maximum of over 100° F. On Sept. 7 a rain storm set in which continued as shown in the accompanying table.

Date	Duration	Total precipitation, in.	Rate, in. per hr.
Sept. 7	25 min.	1.10	2.64
Sept. 10	3 hr. 30 min.	1.77	0.50
Sept. 11	1 hr. 30 min.	0.57	0.38
Sept. 12	.....	3.18	....
Sept. 13	.....	2.47	....
Sept. 14	.....	0.18	....
Sept. 15	3 hr.	0.10	0.03
Total.....		9.37	

Cloudy all these days. Total for September 12 in.

The blocks along Tyler Ave., a 70-ft. street, began to heave in spots on Sept. 8, on Sept. 11 (3.44 in. of rain having fallen on them) when the view in Fig. 2 was made, street-car traffic was stopped, and other street traffic seriously hampered; on Sept. 15 the heaving had reached its maximum, the views in Figs. 3 and 4 showing to what extent this heaving had gone. No regularity in the spacing of the disturbed sections could be noted, but the heaving was general over the whole area paved under this contract. As the views show, there was a distinctive type of transverse and of longitudinal failure, and in general the failure from expansion across the roadway predominated. It is not thought, however,

FIG. 2. LONGITUDINAL EXPANSION OF WOOD-BLOCK PAVEMENT, LONGVIEW, TEX.
(Tyler Ave., looking East from near Center St., Sept. 11, 1913.)

that the individual blocks expanded in one direction more than another, but that the weakness of the crown curve acted to allow failures across the roadway.

On examination of the street, the fine sand cushion below was found packed very hard, and seemed to be almost impermeable, thus precluding any drainage away from the base of the blocks through the sand cushion. The expansion across the roadway was measured and

*Resident Engineer, Aetna Engineering Bureau, Longview, Texas.

was found to be about 8¼ in. across a 68-ft. street. On Sept. 14, three sample blocks were taken and weighed, the mean weight being 56.9 lb. per cu.ft. On Oct. 6, after 23 days' drying at an even temperature of 70 F. these three sample blocks were again weighed on the same scales, and showed an average weight of 47.4 lb. per cu.ft. From over 9 in. of rain these blocks had absorbed an average of 9½ lb. of water per cu.ft. After drying 14 more days a further loss of 4.3 lb. was shown, the mean weight then being 43.1 lb. per cu.ft., a total loss of 13.8 per cu.ft. after 37 days' drying.

The pavement was laid under a guarantee clause of five years and under this guarantee the contractor has completed a relaying, without driving, of the worst sections, and on a coarse sand cushion. The pavement is now in good condition. Before leaving it, however, the pavement will be swept clean and a seal coat of asphalt of about 125 penetration (Dow machine) will be applied.

The contributing causes of the phenomena, in the order of their importance, were concluded to be:

(1) Extreme weather conditions of 65 days' drought followed by 8 days of rain in which 9.37 in. fell.

(2) The removal of the protective sand covering too soon after the completion of the pavement.

(3) The use of extremely fine sand for the cushion.

(4) Laying the blocks too tight.

(5) Neglect to sprinkle and oil at intervals.

(6) Pavement of this type too wide (70 ft.) for the traffic that it has to carry.

In conclusion it may be said that wood-block pavements which may be subjected to such severe climatic conditions, should be laid loose with an asphalt filler, wide expansion joints being left along the gutters, a coarse sand should be used for the cushion, and the pavement should be kept sprinkled with water, and be oiled at intervals of two or three months.

Further Data on Longview Pavement

By P. E. Green*

The foregoing description by H. N. Roberts, resident engineer for the writer's firm at Longview, Tex., was submitted to us by Mr. Roberts before publication and in general was approved. It seems best, however, to follow it with a more careful diagnosis of the trouble, since Mr. Roberts was not fully informed on some points.

The timber was treated with 20 lb. per cu.ft. of creosote oil, the oil having an average specific gravity of 1.05. The blocks were 3 in. deep, 3½ in. wide and 8 in. long on an average. The timber consisted almost entirely of short-leaf yellow pine, weighing about 32 lb. per cu.ft. dried. The specifications provided that the number of rings per inch should not be less than four and should average six. On distillation, the oil was to conform to the following specifications:

> Up to 150° C.—no distillate; between 150° C. and 170° C.—not to exceed 1½% distillate; between 170° C. and 235° C.—not to exceed 35% distillate; and between 235° C. and 300° C.—not to exceed 35% distillate; the residue to be soft; oil to contain not less than 25% napthalene and not less than 25% anthracine.

The actual character of the oil may be seen from the accompanying sheet of an average test. (Fig. 4.)

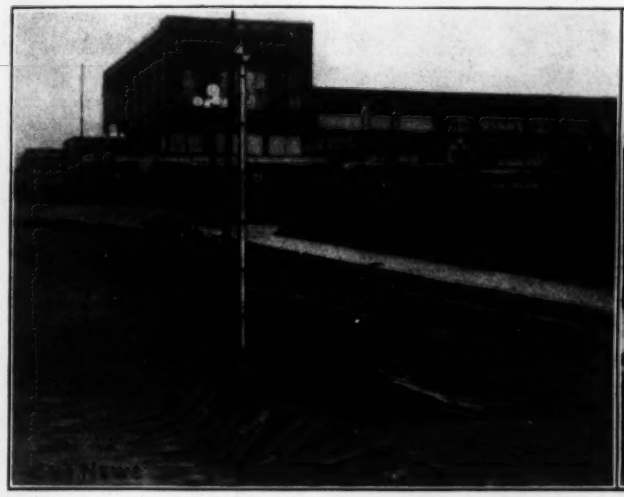


Fig. 3. Tyler Ave., Corner Fredonia St., Looking East, Sept. 15, 1913

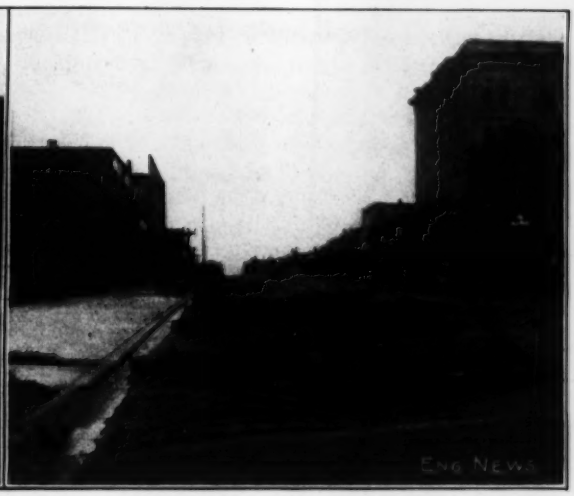


Fig. 4. Tyler Ave., Corner Green St., Looking West, Sept. 15, 1913

Figs. 3 and 4. Transverse Expansion of Wood-Block Pavement, Longview, Tex.

The wood blocks were laid on a 1-in. sand cushion and 5-in. concrete base. The contracting firm was conscientious and thoroughly competent and experienced. Every precaution was taken to secure a good job. All material was tested, including the timber and oil at the creosoting plant.

The entire work was inspected by a very competent resident engineer, who was constantly on the job and had had a very considerable experience in work of this character. The only deviation from the specifications allowed, was the use of a fine local sand for a sand bed instead of a coarse sand as specified. The blocks were laid close, but were not tightly driven, as a rule. The filler was sand with the exception of an alley having a 30-ft. roadway, where an asphalt filler was used. A 2-in. expansion joint was placed on each side of the roadway of the streets, but not of the alley. No difficulty was found in brushing the sand into the interstices between the blocks and rows, and the entire pavement was covered with ½ in. of fine sand. Through a misunderstanding, however, the Superintendent of Streets cleaned the pavement of its overlaying sand within a few days

*Consulting Engineer, the Aetna Engineering Bureau, 17 N. La Salle St., Chicago, Ill.

after the work was completed and before the sand filler had time to become thoroughly compacted in the joints. Following the construction, the streets were frequently cleaned and as the writer was often in Longview during the succeeding two years, he noticed that the joints were never thoroughly filled.

The summer of 1913, as will be remembered, was an exceedingly hot one in the Southwest. The thermometer for days registered over 100° F. For 65 days there was practically no rain. The pavement is very wide—70 ft.; as is the custom of a great many Southern cities. The traffic is what might be expected of a town of 7000 inhabitants and confined largely to the center of the roadway. Along the sides of the streets there is practically no traffic, and many of the individual wood blocks appeared as if they had never had a wheel run over them.

The city of Longview has a very inadequate water-supply at this time; water being obtained from deep wells, whose capacity is so limited that great care must be taken not to waste any. There is very little sprinkling of streets, therefore, and during this long and hot spell it was noticed that the wood blocks not receiving traffic, were beginning to curl up and become distorted in the sun.

During the past year there had been several swellings after very heavy rains, but these had been promptly repaired and had not caused any great comment. After the wreck caused by the rains of Sept. 8-15, however, criticism was very extensive, though it was largely silenced by the simultaneous arrival of the consulting engineer and the contractor, and the immediate active work of repair without any charge to the city. It was also learned that many cities within a radius of 300 miles, subject to the same rains, had had similar and quite as extensive trouble with their wood-block pavements.

The repairs were made under the instructions of W. W. Marr, a member of this firm, who had gone to Longview as soon as the seriousness of the damage was ascertained. The Roach & Mannigan Paving Co., of Fort Worth, who had originally laid the pavement, through its vice-president, R. W. Colglazier, very promptly and without questioning its liability, made the extensive repairs required. Some idea of the existing conditions on Sept. 15 may be obtained, when it is stated that 40% of the entire pavement was relaid, at an expense of about $700 for labor alone.

The method in making the repairs was: first, taking out the old sand cushion and replacing it with a very coarse mortar sand; second, laying the blocks rather loosely; and third, in particular, requiring that all closure blocks should have a full even bearing against the adjoining blocks. This last point was considered very important, as it is only in this manner that the full strength of the timber can be used when it is subject to compression.

An examination of Mr. Robert's data will show:

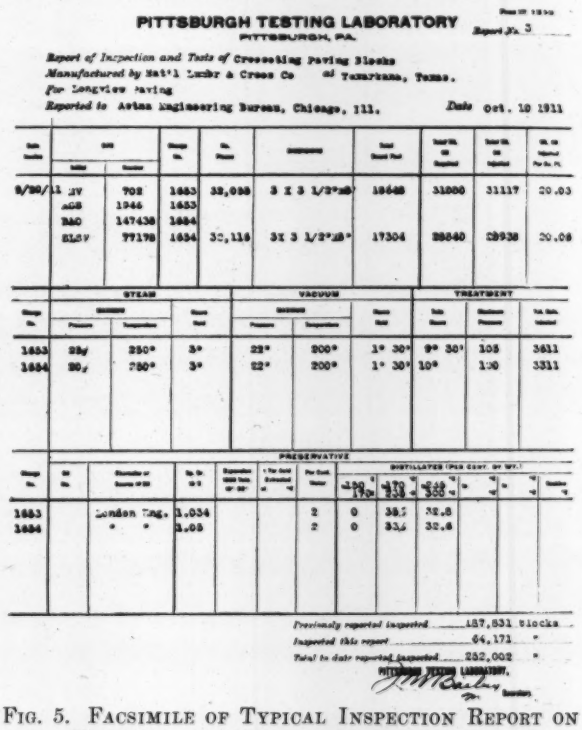
(1) That the blocks absorbed at least 32% by weight of moisture;

(2) That nearly 50% of the contained oil has evaporated or disappeared. The existing blocks when split open and examined were found to have a somewhat bleached appearance. The impregnation was quite thorough, but the upper or wearing side of the blocks showed a distinctly lighter color than the lower, and the entire block when split did not have the dark oily appearance which was apparent when the blocks were laid.

(3) The absorption of the moisture was followed by a very considerable expansion of the blocks, amounting as has been stated to about 8 in. in about 68 ft. Apparently the oil failed to waterproof the blocks, as they absorbed nearly as much moisture as untreated timber would do under the same circumstances.

(4) The fine sand used instead of the coarse sand specified for the sand cushion became nearly impermeable to water and thus the drainage under the blocks was very poor.

(5) The removal of the sand spread upon the blocks for filling purposes in too short a time after it was applied prevented the thorough filling of the joints.



PITTSBURGH TESTING LABORATORY
PITTSBURGH, PA.

Report of Inspection and Tests of Creosoting Paving Blocks
Manufactured by Nat'l Lumbr & Creos Co at Texarkana, Texas.
For Longview Paving
Reported to Aetna Engineering Bureau, Chicago, Ill. Date Oct. 10 1911

Date Charged	Cut		Charge No.	No. Pieces	Species	Total Board Feet	Total Wt. Air Dried	Total Wt. Impregnated	Wt. Oil Injected Per Cu. Ft.
	Order	Number							
9/20/11	JV	702	1653	32,000	3 X 3 1/2"x8"	18648	31000	31117	20.03
	AGS	1946	1653						
	BAO	147436	1654						
	SLSV	77178	1654	32,116	3X 3 1/2"x8"	17304	28840	28938	20.06

Charge No.	STEAM Pressure	STEAM Temperature	STEAM Hours	VACUUM Pressure	VACUUM Temperature	VACUUM Hours	TREATMENT Initial Reading	TREATMENT Maximum Pressure	TREATMENT Net Gals. Injected
1653	25#	250°	3*	22"	200°	1° 30'	9° 30'	105	3611
1654	20#	250°	3*	22"	200°	1° 30'	10°	1:0	3311

Charge No.	Car No.	Number of Boards in Car	No. Gals. per Cu. Ft.	Expansion when Drawn off	Per Cent Evaporated	Per Cent Water	PRESERVATIVE DISTILLATES (PER CENT. OF WT.) 410° - 437° F.	437° - 455° F.	455° - 518° F.	Over 518° F.	Residue
1653		London Eng.	1.034			2	0	33.5	32.8		
1654		" "	1.05			2	0	33.5	32.8		

Previously reported inspected ..... 187,831 Blocks
Inspected this report ..... 64,171 "
Total to date reported inspected ..... 252,002 "

PITTSBURGH TESTING LABORATORY,
By J. M. Bailey
Inspector

FIG. 5. FACSIMILE OF TYPICAL INSPECTION REPORT ON WOOD BLOCK USED AT LONGVIEW, TEX.

(6) The lack of any considerable traffic using the sides of the roadway operated against the waterproofing of the surface by this means, as no mat of the wood fibers was formed, as is usually the case when streets have a large traffic. This, taken with the lack of sprinkling of the blocks during the exceedingly hot spell, and the consequent curling of the blocks under the sun made the surface almost sieve-like.

(7) The blocks are shallow, being 3 in. instead of 4 in., as is usually the case. This depth of blocks is quite common in the South. Many of the blocks were found to have broken under the heaving action. If these blocks had been deeper, they would probably have had strength to resist the pressure without distortion. Once distortion is started, it will extend very rapidly until the entire surface returns to a state of equilibrium.

CONCLUSIONS

Some of the conclusions which might be drawn from the above observations are as follows:

(1) The weather conditions were nearly unprecedented. It is very doubtful if any wood-block pavement in this location and under these conditions could have escaped uninjured.

(2) A bituminous filler is probably superior to a sand filler, although it should be noted that the alley which was part of this improvement, having a bituminous filler, was nearly as badly affected as the other parts of the paving having sand filler. It should also be stated that the alley pavement was constructed of culls (mostly coarse timber), and this porous wood would probably offset, to some extent, the advantages of the bituminous filler.

(3) Roadways should not be wider than the traffic, present and future, requires. This, without doubt, had much to do with the trouble.

(4) The wood blocks should not be less than 4 in. in depth in this climate. A 3-in. block would do better in the North than in the South.

(5) It would seem as if the quality of the oil is still of a disputable nature. Apparently 50% of the oil used in these blocks has disappeared. There is practically no waterproofing apparent. From a preservative point of view, the oil has so far been thoroughly successful and there has been so sign of decay of any kind. The question of the character of the oil needs further study. It would seem that the light oil is best for streets of considerable traffic, but more efficient waterproofing is required for wide pavements in small towns.

It seems logical to require different standards for different locations, and not a fixed standard for all.

(6) During hot spells, the pavement should be frequently and thoroughly watered. It may be well to give it an occasional dose of oil, though this last is very problematical. The oil may prevent the applied water from reaching the blocks during the hot dry weather, but leave it open to the attack of a deluge.

(7) A very coarse sand bed should always be insisted upon where a sand cushion is used for this pavement.

(8) Water is the great enemy of the wood-block pavement. The strength in compression of a saturated pine block may be only one-third that of the dry block. This is shown very clearly in Bulletin 70, Forest Service, U. S. Dept. of Agriculture, from which is quoted the following:

> Moisture has more effect on the strength of wood than any other extrinsic condition. Though this effect is generally temporary, it is far more important than is commonly realized. As the moisture of a piece of wood is reduced by drying, the strength of the wood increases, and as moisture is reabsorbed the strength of the wood, up to a certain limit, is again reduced. So great, indeed, is the effect of moisture that under ordinary conditions it outweighs all the other causes which affect strength, with the exception, perhaps, of decided imperfections in the wood. The desirability of measuring and defining this effect is therefore obvious.
>
> The results show that drying produces a remarkable increase of strength in the wood. When artificially dried until only about 3½% of the moisture remains it is several times stronger than in the green or in the water-soaked condition. How many times the strength is multiplied in drying to this degree in the case of each of the following species is thus expressed in figures:

Species	In compression parallel to grain	Ind. bending
Longleaf pine	2.9	2.5
Spruce	3.7	2.8
Chestnut	2.8	2.1
Loblolly pine heartwood	3.0	....
Red fir	2.6	....

> For a still drier state these ratios are even greater, in the case of spruce compression being as high as four for a condition of 1% of moisture. In other words, a completely dry spruce block 1 in. square will hold up a dead load four times as great as that which a green block of the same size will support.

(9) Every effort should be made to reduce the crown of a wood-block pavement to a minimum. Since the crown is only a drainage provision, on streets having a longitudinal grade of one foot in a hundred, the crown may safely be reduced to ½%, care being taken to eliminate all depressions in the surface.

Repair and Maintenance of Various Kinds of Pavement, Chicago, Ill.

Some interesting statistics on the cost of pavement maintenance and repair are given in the 1912 annual report of the Department of Public Works of Chicago. While the figures are, of course, very general and cover a great variety of repair work on pavements of greatly differing ages, yet the figures cover so much work of each kind that to a considerable degree they do give comparative maintenance costs for various types of pavement under Chicago conditions. The cost figures are comparable because all the pavement repair work is now done by the city's own employees and under the same conditions, with the exception of asphalt repairs, as explained later.

The following table gives the areas of various kinds of paving in the city on Dec. 31, 1912:

Kind	Total, sq.yd.
Macadam	9,616,000
Cedar block	4,380,000
Asphalt	2,759,000
Brick	1,083,300
Granite	717,700
Granitoid	58,400

The cost of maintenance is referred to the total number of square yards of pavement of a given kind out of reserve and maintained during the year 1912, and the cost of repairs is referred to the number of square yards of each kind of pavement repaired during the year.

MACADAM—This work was done by the city at a cost per sq.yd. a trifle higher than in the previous year (1911). At the close of the year, the pavements were stated to be in better condition than ever before. The average cost of maintenance (of 9,616,000 sq.yd.) was 2c. per sq.yd., but this figure is somewhat misleading, due to the fact that on account of the immense mileage under maintenance, it was impossible to keep all in repair with the funds available.

The macadam pavements are stated to be a constant source of annoyance and complaint, and to keep them in complete repair the cost of maintenance would be enormous; and it is recommended that no more macadam pavements be built, and that the present ones be replaced with hard pavements as soon as possible. The cost of repairs (to 919,080 sq.yd.) per sq.yd. was 20.6c.

CEDAR BLOCK—The repairs to cedar-block wood pavements consisted of replacing worn blocks with new cedar blocks. The average cost of maintenance could not be figured because a very large percentage of the streets are in a condition beyond repair. A good many old cedar-block pavements are in the poor residential districts and were repaired by putting on a stone wearing surface, 3 or 4 in. thick, which has put them in good passable condition. The average cost of repairs (to 5902 sq.yd.) per sq.yd. was 56.3c.

ASPHALT—The average cost per sq.yd. of maintenance is figured on a basis of the amount of repair work done on streets out of reserve (2,059,000 sq.yd.). Over 700,000 sq.yd. were released and came out of reserve after the repair forces had finished work for season; if this amount were taken into consideration, the average cost of maintenance (of 2,759,000 sq.yd.) would be reduced from 5.1 to 4c. per sq.yd.

This was the first year that the city had attempted to do its own asphalt repairing; and on account of not having an asphalt plant, it was necessary to buy asphalt mixture and binder under contract. This material was bought at the contractor's plant and hauled to the street by the city's teams. The repair work was done by city day labor. The cost of repairing 76,488 sq.yd. averaged $1.37½ per sq.yd.

BRICK—All brick pavements out of reserve were maintained in first-class condition. Old brick pavements were found hard to maintain because the bricks in old streets wear down so far that it is almost impossible to join the new bricks with the old and make a uniformly smooth surface. It is believed these old brick pavements can be better and more cheaply repaired by using the old brick pavement as a foundation and then putting on 2 in. of asphalt for a wearing surface. The brick pavement in subways required much attention and it is recommended to substitute granite block in such locations. The cost of maintenance was 5.65c. per sq.yd., and the cost of repairs to 58,284 sq.yd. was 99.8c. per sq.yd.

GRANITE—During the year, the old pavement on a number of bridge approaches was replaced with new granite block which makes the average cost of repairs a little higher than it would be in an ordinary year. Also, on several heavy traffic streets, it was necessary to replace a large percentage of the old blocks with new ones. The average cost of repairs was also increased on account of using pitch filler on all repair work, which had not been done before. The granite-block pavement on steep bridge approaches has become smooth and it is suggested that if a suitable hard sandstone can be had, it would prove more satisfactory so far as slipperiness is concerned, if it could withstand the heavy traffic. A few small experiments made with this class of material have given satisfactory results. The cost of maintenance of granite-block pavements was 6.1c. per sq.yd. and the cost of repairs (to 54,153 sq.yd.) was 73.2c. per sq.yd.

OILING—The cost per sq.yd. of oiling has been decreased from 1.43 to 1.35c. per sq.yd., notwithstanding that a better-grade oil at a higher price is used. The low cost is due to the fact that the macadam streets, which are oiled from year to year, are being coated with a heavy asphaltic mat, which does not allow the oil to penetrate to a very low depth, and, therefore, these old pavements do not require so much oil to the square yard, nor is more than one application a year necessary. Repairs to macadam pavements were made by giving the streets an application of asphaltic oil and covering the oil coat with clean sand, granite chips, or coarse limestone screenings, more cheaply than by any other method.

Two grades of oil were used, a heavy asphaltic oil and a light asphaltic oil. It is believed that with care, the heavy asphaltic oil proves to be better in the long run, but that on account of its slow penetration, it remains longer on the surface and is consequently objectionable. Whenever this grade of oil is used, it is advisable to h[eat] the oil and apply it hot, covering the warm oil coat[ing] with some kind of sharp screenings. It is believed t[hat] for general use, the light asphaltic oil will prove mo[re] satisfactory.

MISCELLANEOUS—A total of 21 sq.yd. of creosot[ed] block was repaired at a cost of approximately $1 per s[q.] yd. Dangerous holes aggregating 54,723 sq.yd. in stre[ets] and alleys, were repaired with cinders at a cost [of] $9902.18, or 16.26c. per sq.yd. Dangerous holes in a[s]phalt pavements, aggregating 39 sq.yd. were repaire[d] with planking at a cost of $65.69 or $1.684 per sq.yd.

SUMMARY—The accompanying table gives a genera[l] summary of the foregoing text:

Kind	Total sq.yd. out of reserve and under supervision	Total sq.yd. repaired	% of area of pavements repaired	Total cost of repairs	Repairs average cost per sq.yd.	Maintenance average cost per sq.yd.
Macadam	9,616,000	919,080	9.5	$190,600	$0.2065	$0.0199
Cedar block	4,380,000	5,902	0.135	3,327	0.5636	...
Asphalt	2,059,000	76,488	3.7	105,161	1.3750	0.5100
Brick	1,029,000	58,284	5.6	58,170	0.9980	0.0565
Granite	649,000	54,153	8.3	39,668	0.7325	0.0611
Oiling	5,311,144	.....	...	72,086	0.0135	.....
Cinders	54,723	.....	...	9,902	0.1626	.....
Creosoted block	21	.....	...	20	0.9738	.....
Plank on asphalt	39	.....	..	66	1.6843	.....

The Duties and Trials of the County Engineer—A big problem to the county engineer is the education of the people in the matter of building permanent work. The dollar is held so close to their eyes that it obstructs their vision and prevents them from seeing that a wooden bridge or culvert is more expensive in the end than one of concrete.

The most common error in the "home-made" plans of concrete culverts by the township boards is in building them too light. They think that so long as the material is concrete the design is of little importance. In one instance a township board designed a reinforced-concrete retaining wall. In less than one year it fell. They called upon the county engineer to find why it failed and how to remedy matters. Upon investigation I found that the reinforcement had been placed in the center of the cross-section of the wall, the width of whose base was less than one-eighth of its height.

It is not uncommon to find an attempt to span a ravine or ditch with a bridge or culvert out of all proportion to the drainage area. One township built a 9-ft. concrete arch culvert to drain less than 40 acres, while one mile below on the same watershed a tin-horn culvert was used, guaranteed by the selling agent to carry away the water. Some road officials fail to see that sometimes a change in the bridge site would eliminate the necessity of a large, expensive structure. In one case where the creek crosses the road three times within less than 700 ft., three large wooden bridges have been built. By changing the channel of the creek with slight expense, but one culvert is necessary.

One township trustee concluded that the county engineer's plans for a concrete abutment were too expensive, and ordered the workmen to change its dimensions and build it in less than 2 ft. of excavation on a loose, sandy soil. The County Commissioners interfered, took the work from his supervision, and the engineer's first duty was to blast out the concrete already placed.

Mistakes have been made upon the roads as well as upon the bridges.

A mud hole on one of our public roads had been filled and refilled for more than 20 years. One hour's work setting level and grade stakes, and less than one day's work with a team and scraper opening an outlet ditch, has eliminated the trouble. Year after year they have temporarily mended the same faults in the road and have failed to see that the ultimate expenditure would have more than paid for one permanent piece of construction work.

The township trustees formerly made no attempt to keep cost data. Now they are more capable of estimating the value of different classes of work since they are required to give annual reports to the county engineer, showing the expenditure of all moneys for road and bridge work, giving the per cent. used in dragging, grading, concrete, stone work and wooden bridges.

[R. F. Gallup, County Engineer, Marshall County, Kan., in a paper before the Kansas Engineering Society.]

EDITORIALS

Diesel Engine Manufacture in the United States

Announcement in our last issue that one of the largest steam engine builders in the United States, the McIntosh & Seymour Co., of Auburn, N. Y., is to take up the manufacture in the United States of a Swedish type of Diesel engine for both stationary and marine service, is one of much importance and interest.

Notwithstanding the leading position of the United States in crude-oil production, every other manufacturing nation in the world is far in advance of us in the manufacture and use of crude-oil engines. Many causes have operated to produce this result; but whatever these causes, the fact does no credit to American mechanical engineering ability and progressiveness. The Swedish Diesel engine which is now to be taken up for manufacture here has made an excellent record in Europe and its builders and designers there are to take an active interest in its manufacture here.

It may be, as is often claimed, that European engineers have gone to an extreme in the use of crude-oil engines; but the steady increase in the price of gasoline here tends to make power users in this country also turn more and more toward the crude-oil engine. In the Southwest and on the Pacific Coast especially, there is an enormous field for the use of crude-oil engines, which American manufacturers have hitherto failed to work to its full extent.

⁂

Excessive Street Widths

In the article on the heaving of wood-block pavement on another page of this issue, the extreme width of the pavement between curbs is very reasonably given as one of the leading causes for the extraordinary failures. A combination of circumstances sufficient to cause the Longview failures should be extremely rare, but for other reasons the use of such a wide paved street, 70 ft. in this instance, in small cities, is the rankest kind of extravagance which engineers should combat. It is beyond all conception that a city of 7500, such as Longview, should have traffic need for a street with a roadway surface 70 ft. wide, except on those festive occasions when the circus visits town, or the local Odd Fellows parade through the main street. Nevertheless, it is quite common in the newer cities of the West and in the old cities of the South, to find construction and maintenance charges burdened with such extreme widths. In both cases it is a result of originally cheap land combined with the well meant intention of giving a certain spaciousness to the city.

It is entirely laudable to make the distance between building lines or between extreme curb lines in a city as wide as possible, but it is not at all necessary to pave this entire width. Rather, it is highly desirable to have a space in the middle of the street curbed in and filled to about the street level, to be used either as a shaded walk, as in the case in Commonwealth Ave., in Boston, or as a park space, as has been done in upper Broadway in New York. To park the area might be as expensive as to pave it, but the resulting effect would be immeasurably superior. If economy is desired, however, the middle space need only consist of filled earth, which is quite as attractive as a broad expanse of paved street, and much cheaper.

⁂

Should Concrete Be Mixed Longer Than Is Now Common?

It is probably nearly an accepted principle among constructors that the order of placing concrete material in a mixer is of no importance. Occasionally a specification is written and more rarely followed under which it is required that the component parts of the concrete be placed in the mixer in some prescribed order, but the general practice is to throw in the cement, aggregates and water in any convenient order, or, in case a measuring hopper is employed, all at once. In hand mixing, of course, the old practice of first mixing the dry sand and cement still prevails, but that is because when all the materials are thrown on the board together and doused with water it is difficult to get men to turn over the mass of wet concrete long enough to insure a well mixed mortar. The stronger and more efficient machine is thought to remove this difficulty.

An exception to this general rule is noted in this issue in the article describing some pressure tests on concrete pipe. The company making these tests attributes the density of the concrete obtained, first, to its richness—a 1 : 1½ : 2½ mix is used—and, second, to the method of mixing in which especial attention is paid to the order of placing the materials in the mixer.

According to their method the mixer is first charged with the proper amount of water (established by experience and observation), and into that the cement is dumped; the mixer is then turned until a well mixed grout results. Into this is then dumped the stone and after this has been turned sufficiently to insure the coating of all the stone particles the sand is put in and the turning continued until the sand particles are well coated and have apparently filled all the voids in the cement-coated stone.

It may be that the users of this method are correct in their assumption that the order of placing is responsible for the exceptionally dense concrete which they achieve, but to us it seems that the effectiveness of the method is due not so much to the order of placing of the materials as to the length of time taken between the placing of the separate components, which added together make the total length of time of mixing somewhat longer than in the normal mixing of concrete.

This naturally leads to the query "Is enough attention paid to the length of time of mixing in machine-mixed concrete"? Are not most constructors too hasty in getting the batch out of the mixer? There is before

us a record on a piece of Western construction in which it is stated that 2150 cu.yd. of concrete were mixed in an 8-hr. day in four 1-yd. mixers. This is somewhat more than a mix a minute per machine. Regardless of the type of machine used, would not a two-minute period have given a concrete enough better to warrant the use of more machines with their additional cost of purchase and operation?

As construction is now generally carried on the time of mixing is governed entirely by the observing eye of an inspector or superintendent. When to him the various parts that go to make up the concrete seem to have reached a proper intermingling the batch is dumped. If it is a fact that after a certain amount of mixing, easily determined by the expert eye, the component parts of the concrete become so thoroughly intermixed that no perceptible increase in quality of the concrete will result from further mixing, this method of ocular inspection is correct enough, but if it is probable that an increase, even slight, in future strength may result from mixing the concrete beyond the time when it *seems* to be thoroughly mixed, then in the scientific development of concrete construction such time should be ascertained.

We believe that some tests have been carried on to investigate the proper time of mixing concrete, but these tests have not been so conclusive nor have they had such wide publicity as to be of much value. There is a field here for future investigation, which we trust some of our testing laboratories will soon take up. Undoubtedly, most of the concrete which is made is mixed in too short a period. If by adding to that period we can increase the density of the concrete and thus improve its water-resisting qualities or prolong its future life, we are certainly justified in the additional expense of extra mixing. It may be difficult to estimate precisely the effect of this additional mixing, but unless there is absolute certainty that it does no good it would be at least a good insurance. The difficulty, of course, is not in determining whether additional mixing is desirable but in ascertaining some method by which the exact time of increased mixing may be rationally determined, and that is the field of the testing engineer.

State Railway Control in the United States

It is of great interest to notice how closely parallel are the lines of current events in connection with the railways, their employees and the public, in England and in the United States. The situation in England is well summarized in a brief article by an English contributor on another page of this issue. As there set forth, British railways were compelled to make large advances in employees' wages as a result of the general railway strike two years ago. On account of the increase in operating expenses resulting from these wage advances, the British government has permitted an increase in railway freight rates to offset the advance.

In the United States similar concerted action by the railway employees' unions has brought about one advance after another in wage rates during the past three or four years. The threatened strike of railway conductors and trainmen through the entire territory east of Chicago was averted last summer by submission of the whole matter to an arbitration commission. By the report of this commission just rendered, this class of employees is granted a general advance of 7% in wages.

As a result of this increase in operating expenses, together with the burdens imposed by full-crew train laws, the advances made by a previous arbitration commission to locomotive engineers, and other growing expenses, the railways are now appealing to the Interstate Commerce Commission for permission to make a general advance of 5% in freight rates and the request is likely to be granted. While previous petitions of the railway companies for permission to advance rates have been strongly opposed by associations of shippers, little opposition has appeared at the present time. It appears to be generally recognized by the business community that some advance in freight rates has become necessary in order that the railways may continue solvent and may be able to obtain the capital necessary for improvements and extensions.

It is well recognized, however, on all sides that we are by no means at an end in the readjustment of the relations between the railways and the public. Affairs in Great Britain have been brought to a head by the announcement of the appointment of a Royal Commission to inquire into the general relations between the railways and the public. While the majority of public opinion in Great Britain is doubtless still strongly adverse to any such radical move as the purchase and operation of the railways by the nation, it is frankly recognized there that the public is steadily being educated in this direction, and the question will soon become a very live issue. The same condition of unrest exists in this country, although at the present time it takes the form of urging measures for further government control over railway companies. The financial quagmire in which the directors of the New Haven R.R. Corporation have landed the entire railway system of New England, with resultant loss to the many thousands of small investors in the securities of New England railroads, has done more than any other event in a quarter of a century to turn public opinion in favor of the government regulation of the financial administration of railway companies as well as their operation. There have been long periods during the twenty-seven years since the Interstate Commerce Commission was established when the Commission had very little power and such recommendations as it made fell upon deaf ears. There have been times, indeed, when a reaction which would abolish the whole system of Federal control seemed not impossible. The situation at the present day, however, is exactly the opposite. Not only is federal control over railways and other interstate utility corporations being rapidly made more and more complete, but State control is being exercised with a far firmer hand.

That serious evils, injustice and even public injury often grow out of the present public regulation of these corporations is realized by most well informed men; but these evils are not to be remedied by any reactionary movement. There is no possible doubt that public control over all utility corporations has come to stay. The real question here, as in England, is whether that control can be made so successful and so fair to all the interests involved that it can be continued as a permanent basis without resorting to state ownership and management.

The Recent Disasters to Lake Shipping

The hundreds of lives sacrificed in the recent storm on the Great Lakes ought to teach an emphatic lesson as to the need of further improvement in the standards of lake vessel construction. It is well known that the lake ore carriers have reached a size averaging much larger than the average size of ocean freight steamers. But while structurally they are considerably more staunch than the vessels built a dozen or 15 years ago, they are deficient in propelling power and in ability to endure such heavy weather as the recent terrific storm. The prevailing type of lake vessel is the bulk-cargo carrier in which the hold is left almost without division in order to facilitate the use of mechanical appliances for cargo handling. Desirable as this end is, it makes the cargo subject to shifting when the vessel experiences heavy weather. The construction of hatches and hatch covers, also, is flimsy compared with that on ocean-going tramp steamers, where it is known that the vessel may at any time be flooded by heavy waves. Many large lake vessels of recent construction, which were caught in the recent storm, had too little power to make headway against it and were driven into shoal waters to be broken up by the waves. It is probable that some of these casualties were traceable to the vessels having insufficient water ballast when running light, so that the propeller was too near the surface of the water and lost its effectiveness in a rough sea. The *Toronto Globe* calls for a conference of the United States and Canadian Government authorities to revise the rules for freight-carrying vessels on the lakes in accordance with the lessons of this latest marine disaster and such action is as certainly demanded by the conditions as was revision of the lifeboat rules after the "Titanic" disaster.

What is a Leveler, and Why?

The license-law agitation and a great many other professional questions in engineering during the last few years involve the essential question: What is an engineer? The lay public has more or less hazy and contradictory opinions on this question. Engineers themselves have no opinion at all, so to say, since they do not recognize the term engineer as denoting a specific single kind of professional man, but divide the profession into a large number of branches and sub-branches. At best they would undertake to answer a more limited question, as, what is an electrical engineer, or a civil engineer?

What is a civil engineer? Referring this question again to the lay public, we find that the answer is a very hazy one, involving usually transits, stadia rods, hip boots and piledriving. If the question is asked within professional circles, quite different answers are likely to be obtained. For example, there are still some men who believe that a civil engineer should be conversant in thorough detail with all the subdivisions of the field. Others frankly admit that sanitary engineers know little about structural matters, structural engineers know little about earthwork construction men know little about river and harbor work, etc. Correspondingly, professional practice, as well as the instructional practice of engineering schools, etc., have established various subdivisions. For these professional subdivisions the defining qualifications can be fixed with some degree of exactness, i.e., it is quite possible to define sanitary engineer, structural engineer, etc.

There are subdivisions of another kind, which are recognized in the makeup of engineering organizations, in the engineering bureaus of governmental departments, etc. They are functional differentiations, embracing such grades or titles as structural draftsman, designing engineer, chainman, etc. Each subtitle is supposed to define precisely what kind of service and what qualifications are required in that grade. The relation of the different titles to each other is a matter of promotion and pay.

Since a great amount of engineering work involves this functional subdivision, it is highly important that the different classes should be properly chosen, and each one accurately defined. At present there is neither proper choice nor proper definition. The choice of classes is a very vexatious matter, as was shown recently, when an engineering society put a special committee to work to recommend a uniform classification of engineering employees in the various bureaus of the City of New York, the motive being that the existing grading is highly heterogeneous. So much the more important is it, then, that the grades actually used be defined in clear and correct terms. Unfortunately, the definition of grades, *in the public service*, depends on such bodies as civil-service commissions. In using the word "unfortunately" we do not mean to reflect on such commissions, but to express the opinion that grade-definitions would better be fixed by technical authorities, rather than left subject to the changing interpretations of different examining boards. Precise definition would afford the further advantage that inheres in an explicit definition as against one which must be read out of the questions asked in the civil-service examination.

With this in mind we would call particular attention to the civil-service examination questions for leveler, printed in this issue.

Leveler is one who levels. The meaning of the term is clear, and so far as we know, practice always agrees with this self-evident meaning in every particular, levelers being employed for the particular purpose of running levels. Levelers are *not* employed for the following operations: Designing roof trusses; designing reinforced-concrete beams; designing bridge details; planning waterworks; planning hydraulic power houses; supervising the removal of old buildings; making foundation tests; inspecting waterproofing; buying excavating machinery; building pavements; inspecting timber.

There are numerous other things that levelers are not employed to do. We list the above only because they are the items which levelers must be competent in, according to New York State's latest civil-service examination for leveler.

It will be conceded that to examine a leveler requires asking him questions (or otherwise testing his competence) on leveling. When such an examination *contains nothing whatever concerning leveling*, there is legitimate occasion for surprise. *The present examination contains no single question devoted to leveling*, and only two or three which are in any way connected with surveying.

We do not mean these comments in criticism of the civil-service commission which planned and conducted the examinations. Doubtless they had good reasons for

formulating their questions as they did. Doubtless these reasons were honest and were based on a full knowledge of the subject in question, as well as *the conditions under which levelers are employed in New York State.* Things are not always what they seem.

We submit, however, that the conditions cited make it desirable that a competent independent association of engineers should determine and authoritatively set forth what a leveler is.

The Investigation of the New York State Highway Work

A searching investigation is being conducted by District-Attorney Whitman, of New York City, into the collection of political assessments from contractors engaged on New York State work and firms supplying material therefor, and is attracting wide attention. Honest engineers and contractors and dealers in engineering supplies will join in hearty approval of Mr. Whitman's energetic work, and in the wish for "more power to his elbow."

The results of the investigation thus far made public are in substantial agreement with what has been heretofore rumored, that the concerns supplying material for use on state contracts were called on to pay an assessment to political leaders, based on a percentage of the total value of their business, which amount it was understood they were to obtain by increases in prices of material or reduction in quality, or both.

It is true that many men who call themselves good citizens would defend such an arrangement on the ground that it was only fair that the concerns holding profitable contracts should "give up" to help support the political party in control. The practical result of such "giving up," however, has been in many cases that the supplymen who furnished such material and the contractors who used it have done the work as they pleased regardless of engineering supervision.

Of course we are far from saying that all the work has been bad or that the State has gotten nothing whatever for the many million dollars it has poured into State road construction, but there is no doubt at all that the results fall far short of what they should be and what they would have been had honest and competent engineers been allowed to control the work in the public interest.

It need not be thought, either, that Mr. Whitman is simply thrashing over old straw; for even though his department can only investigate the crimes and misdemeanors which have been committed in the past, the facts that he is bringing to light have a very important bearing on the work the State still has to do with the second $50,000,000 good-road bond issue. There is no doubt at all that the good citizens of New York need to be very keenly alert if they are to get any better work for this second $50,000,000 than they did for the first.

Every engineer of long experience in highway and street construction will read with appreciation the emphatic statement by John N. Carlisle, Commissioner of Highways, regarding the part of the asphalt industry in connection with political graft. We quote as follows:

The public should remember that the asphalt industry is the unclean thing of industrial life in America. It has left its grimy trail of graft across the continent and has corrupted or attempted to corrupt officials in nearly every [illegible] in which it has done its work. Not content with this, it [illegible] financed revolutions and overthrown governments, and [illegible] is the subject of international complication.

Those who know the inside history of some of the [illegible]phalt concerns will understand that Mr. Carlisle [illegible] speaking with authority. Nor need he have wholly [illegible]fined his remarks to the asphalt industry. It is unfor[illegible]nately true that the whole business of street paving [illegible] highway construction has long been permeated with [illegible] honesty. Men of personally high character have [illegible] often been compelled to "fight the devil with fire" [illegible] order to meet their competitors on their own ground [illegible] else have been obliged to retire from the business.

If any criticism were to be made of Mr. Carlisle's statement it would be that the fault has been by no means on one side. There has been, without doubt, plenty of corrupting graft handed out by asphalt and other concerns to city and county and State officials of high and low degree; but on the other hand there have been plenty of such officials (and their political backers) ready to play the hold-up game on any successful contractor or dealer. This side of the story is expressed in a nutshell by a valued correspondent who writes us:

I would like to see an editorial in "Engineering News" with this heading, "Why Do the People of the State of New York Blackmail Their Contractors for Public Work?"

We can best answer that question by asking another, Yankee fashion: "Why do the people of the State of New York put into high public office men who will engage in or permit such an organized system of blackmail to be conducted"?

Having asked this latter question we may perhaps answer it by saying that it is because the public is in a quandary to know whom to trust. That is the real explanation of the reason why the City of Dayton, Ohio wishing to break loose from the old-time system of inefficient political and corrupt control of public works, offered Col. Goethals a salary of $25,000 a year to become the City's General Manager. We yield to none in admiration for Col. Goethals' ability and achievements; but there are probably a dozen engineers in the State of Ohio thoroughly experienced in municipal engineering work, who, if given full authority, could conduct the municipal business of Dayton as successfully as Col. Goethals himself.

The Dayton offer is, however, a most hopeful sign of the times. It indicates that the public to some extent is beginning to realize that in its eager search to find someone on whom it may place full responsibility for the conduct of public business, its greatest hope lies in the engineering profession. Most public work is really engineering work and should be put in charge of an engineer who possesses technical knowledge, executive ability and a pride in the ethical standards of his profession that will make him proof against the temptations of corrupting graft.

This does not mean that every man calling himself an engineer, or even that every member of the engineering profession in high standing and holding a high position, is therefore worthy of trust, as regards either his technical or executive ability, or his strict honesty. There have been unfortunately conspicuous instances to the contrary.

It still remains true, however, that there are to be found in the engineering profession men who do combine these qualifications which make them worthy of the pub-

trust in such high positions; and the public is learning to rely upon men of this type for positions involving great responsibility.

It is not without interest in this connection to record that in one of the States which has established a Commission to study methods for increasing economy and efficiency in the State service, the investigation thus far has indicated that the best results are to be hoped for by placing all the public work of the State under control of a State engineering organization, made up on a permanent basis, under legislation that will so far as possible insure its being kept free from such political control as has produced the sorry mess in New York's public works.

LETTERS TO THE EDITOR

The Chicago Technical League

Sir—There has been formed in Chicago, Ill., and vicinity, an organization composed of men following the engineering profession, for the purpose of finding ways and means for the advancement of engineers' salaries and standardizing of positions.

The organization is affiliated with the American Federation of Labor, and further details may be had upon application to the secretary.

LOUIS A. HEYN.

Recording Secretary, Chicago Technical League,
32 N. Fifth Ave., Chicago, Ill., Nov. 20, 1913.

Comparative Flow of Ohio and Tennessee Rivers

Sir—In the article "Rock Grouting and Caisson Sinking for the Hales Bar Dam," which appeared in ENGINEERING NEWS, Nov. 13, 1913, the flow of the Tennessee River was compared with that of the Ohio, presumably above the mouth of the Tennessee, and the statement was made that the flow of the Tennessee is somewhat larger than that of the Ohio above the Tennessee. The following table shows that the Ohio River at Wheeling is comparable to the Tennessee at Chattanooga, Tenn., and that the Ohio just above the mouth of the Tennessee is much larger than the Tennessee at its mouth:

COMPARISON OF TENNESSEE AND OHIO RIVERS

River	Station	Area, sq.mi.	Rainfall, in.	Per cent. of rainfall as runoff	Discharge, cu.ft. per sec. Mean annual	Minimum	Maximum
Tennessee	Chattanooga	21,400	47.6	55	41,500	6,000	500,000
Ohio	Wheeling	23,800	41.7	54	39,800	1,300	500,000
Tennessee	Mouth	38,900	....	..	*67,000	*7,800	*450,000
Ohio	Above mouth of Tennessee	103,000	....	..	*225,000	*12,000	*1,000,000

* These discharge values are approximate.

The Tenneessee may, from the effects of heavy rains on its watershed alone, discharge many times more water into the Ohio for short periods than there is flowing in the Ohio itself above the junction of the two streams. Under similar conditions this may occur at the junction of any of the larger tributaries of the Ohio.

In view of the agitation for control of the Ohio and Mississippi Rivers, it does not seem advisable that there should be any misunderstanding as to the relative size of the Ohio River and I have accordingly brought the subject to your attention.

A. H. HORTON,
District Engineer, U. S. G. S.

Washington, D. C., Nov. 17, 1913.

A Further Warning to Engineers in Search of Employment

Sir—Your editorial "Employment and Investment Combined: A Warning," in the Nov. 13 issue, was an instructive and timely article, on a subject which deserves occasional attention but which at this time would warrant special emphasis because of the activity of promoters of such companies.

It is a regrettable fact that these companies are promoted in such a way that it is almost impossible to implicate the promoters in legal action before considerable sums have been taken in and "eaten up" in overhead charges, chiefly the excessive, unearned salaries of the promoters.

There are many things done by these "fake" companies which are not based on sound business principles but which are not apparent to the young engineer who has not held an executive position, and perhaps even then would not be known if the position were in the manufacturing or constructing field. It will be found that these propositions are purely engineering or the selling of "brain service" and that little or no material equipment is required. It is for this reason that it is so difficult to investigate the honesty of the business. It is a simple matter to place a few names on a drafting-room roll and show thereby the business being done. This is fine to show to the "goat," who is in the outer office and does not know until it is too late. In fact the entire records are carefully written up on visionary business.

These companies will have their main offices in one city and advance as their reasons for desiring more men that they are about to start a branch office in some distant city or that a man has resigned on account of ill health. Branch offices will be started by throwing into the new field a full complement of men, which procedure is not sound business for work of a purely engineering character. An engineering business must be built up on a good solid foundation by recognized engineers and cannot be started over night, successfully.

Also, it is well to further warn those who are investigating positions combining employment and investment, of the practice of these companies of approximately duplicating names. A name will be taken and by the addition or dropping of a word the new company's name will be formed. By this means the fake company's name may apparently be found in mercantile agency reports, which is confusing and misleading.

"ONE OF THE GOATS."

Nov. 17, 1913.

Proportioning Natura. Aggregate for Concrete

Sir—In ENGINEERING NEWS, Oct. 9, 1913, p. 722, appears a query asking for information about the method of handling a natural sand and gravel mixture in order to obtain a certain definitely proportioned concrete such as a 1:2:4. The question is asked whether, in practice, "it is customary to procure small lots of uniform sand and gravel and mix them in order to determine the volume of graded aggregate to be used." Obviously this method, i.e., to screen out some of the sand and gravel and remix them in the desired proportions in an attempt to determine the bulk of the natural mixture to be used with a certain amount of cement. would be of use only in the improbable case of the natural deposit being exactly of the proper proportions, in this case 2:4. In all other cases the method used must be to separate by screening through a screen conforming to the user's definition, as to size, of "sand" and "gravel," a measured quantity of the natural mixture. This proceedure will give the proportion of sand to gravel which the mixture contains and a simple calculation will then show how much sand or gravel (obtained by screening some of the material at hand or from some outside source) must be added to every batch of concrete to supply the deficiency in either.

I assume that your correspondent is not concerned about the manner in which the question of how to proportion a concrete for a specific purpose is determined, a question involving the factors of use, strength, waterproofness, economy, etc., but that, upon due consideration of these factors, he has definitely determined upon the use of, say, a 1:2:4 mixture as the one best adapted to his requirements and to the physical characteristics as to voids, sharpness, clearness and gradation of the material he intends using. I also assume that in arriving at this determination he has based his calculations upon an arbitrary definition distinguishing sand from gravel. If these assumptions are correct he will find in my letter in ENG. NEWS, of Aug. 22, 1912, p. 359, details of just such calculations as he requests. The accuracy of results is, of course, dependent on uniformity in the run of natural deposit used, different tests being necessary, with consequent variations in the proportions employed, as the natural composition appears to change.

ARTHUR L. MILINOWSKI,
Asst. Engr. New York State Barge Canal.

Rochester, N. Y., Oct. 14, 1913.

Sir—Referring to the query on p. 722 of the current volumne, I would say that this has become quite a common practice, at least in the vicinity of Buffalo, N. Y.

Experience has shown that when the sand and gravel are sifted out, there is an increase of bulk of 20%. A cubic foot of "graded gravel which runs 0.4 cu.ft. sand and 0.8 cu.ft. gravel would fill the specification requirements exactly; 2 parts of sand and 4 parts of gravel make 6 parts of mixture. This divided by 1.2, would give 5, the number of parts to use with 1 part cement. Any great variation in the natural mixture would, of course, have to be corrected.

EMILE LOW.

Buffalo, N. Y., Oct. 11, 1913.

The Calculation of Water-Hammer Pressures

Sir—The article in your issue of Sept. 25, p. 616, giving a diagram for water-hammer pressures, shows results differing materially from those obtained from well known formulas. The original reference is not, for the moment, available but an examination of the formula given, with the assigned values, shows an inconsistency in that the elasticity of the pipe walls is taken into consideration but that the value for the velocity of wave propagation is that which applies only to a rigid pipe.

The same thing occurs in the formula for the time required for a round trip of the wave. The proper value is the actual velocity of the wave, which, in many cases, is materially different from the given value, 4700 ft. per sec., and which depends upon the material of the pipe walls and the ratio of thickness to diameter.

The velocity of wave propagation is nothing more or less than the rate at which the flowing water is able to compensate for the compression of the water and the extension of the pipe corresponding to the increased pressure. The original formulas were based on this fact, as may be shown by careful, extended calculations of an assumed case. The formulas given by Church have been so checked and give consistent results.

Let

E = Bulk modulus of water, 300,000 lb. per sq.in.;
E' = Modulus of elasticity of pipe material,
= 30,000,000 lb. per sq.in. for steel,
= 15,000,000 lb. per sq.in. for cast iron for usual pressures;
$E_2 = E$ as modified by elasticity of pipe walls;
C = Velocity of wave, pipe distention not considered;
C' = Velocity of wave, pipe distention considered;
r = Internal radius of pipe, inches;
g = 386.4 in. per sec., velocity due to gravity;
γ = 0.03604 lb. per cu.in., weight of water;
p = Excess pressure, lb. per sq.in.;
c = Velocity of water, ft. or in. per sec., as noted;
t = Thickness of pipe wall, inches;
T = Time of closing of valve, seconds;
T_r = Time for round trip of wave to reservoir and back;
$\frac{t}{d}$ = Wall thickness divided by internal diameter of pipe.

Church gives the following:

When pipe distention is not considered,

$$C = \sqrt{\frac{Eg}{\gamma}} = 4726 \text{ ft. per sec.} \qquad (1)$$

$$p = c\sqrt{\frac{E\gamma}{g}} = 63.3\,c, \text{ ft. per sec.} \qquad (2)$$

Considering the elasticity of the pipe walls,

$$C' = \sqrt{\frac{E_2 g}{\gamma}} \qquad (3)$$

in which

$$E_2 = \frac{EE't}{tE' + 2rE} \qquad (4)$$

$$C' = 103.5\sqrt{E_2}, \text{ in. per sec.} \qquad (5)$$

$$C' = 8.625\sqrt{E_2}, \text{ ft. per sec.} \qquad (6)$$

$$p = \frac{c\,C'\gamma}{g} \tag{7}$$

$$= 0.000093\,c\,C', \text{ for } c \text{ in inch-second units} \tag{8}$$

$$= 0.0134\,c\,C', \text{for } c \text{ in foot-second units} \tag{9}$$

When T is greater than T_r the pressure

$$p_1 = \frac{p\,T_r}{T} \tag{10}$$

Curves for numerous values of the ratio Rd were constructed from the above formulas for several kinds of material, and all were found to be equilateral hyperbolas, with Rd for abscissas and $\frac{E}{E_2} - 1$ for ordinates, referred to the asymptotes. The constant in their equation

$$Rd\left(\frac{E}{E_2} - 1\right) = K$$

had the value $\frac{E}{E'}$ which for steel equaled 0.01 and for cast iron 0.02.

From the above relations may be deduced the following:

$$E_2 = \frac{E}{\frac{K}{Rd} + 1} \tag{11}$$

$$C' = \frac{4726}{\sqrt{\frac{K}{Rd} + 1}}, \text{ feet per second} \tag{12}$$

$$p = c\,\frac{63.3}{\sqrt{\frac{K}{Rd} + 1}} \tag{13}$$

for c expressed in feet per second and p in pounds per square inch.

$$p = c\,\frac{63.3}{\sqrt{\frac{E}{E_2}}} \tag{14}$$

The Frizell formula given in the article noted is:

$$P_1 = \frac{u}{v} \cdot \frac{E_w}{1 + \frac{2\,r}{f} \cdot \frac{E_w}{E_r}}$$

in which

u = Initial velocity of water;
v = Velocity of sound in water, 4700 ft. per sec.;
r = Inside radius of pipe in feet;
f = Thickness of pipe in inches;
E_w = Modulus of elasticity of water, 300,000 lb. per sq.in. [A typographical error made this read 700,000 lb. in the article in question.—Ed.]
E_r = Modulus of elasticity of pipe material.

The diagram constructed from the above shows a pressure of about 63 lb. per sq.in. for a 12-in. pipe 1 in. thick, and about 50 lb. for an 84-in. pipe ¼ in. thick, for each foot of extinguished velocity.

By assigning to v the true value of the wave velocity for each case and expressing r in inches the figures become 60 and 30.4 lb. per sq.in., which check with the figures given by formula (14) above.

The conclusion to be drawn is that there has been some misconception introduced at some time or other into the formula given in the article mentioned. As given it lacks the means of determining the velocity of wave propagation in an elastic pipe. There are many places where the pipes are so rigid that the elasticity may well be disregarded, but in power work, where governing is important, it is necessary that all the facts be considered. It is especially desirable that the velocity of wave propagation be determined with all the accuracy possible.

S. L. Berry.

329 Rialto Bldg., San Francisco, Calif.,
Oct. 29, 1913.

The Warren Patents on Bitulithic Paving

Sir—In your issue of July 24 you published an abstract of a paper by Linn White, Chief Engineer of the South Park Commissioners, Chicago, read before the Civil Engineers' Society of St. Paul. We desire to reply to certain of the statements made in that paper with respect to our patents as follows:

The question at issue is: Was the Bitulithic type of pavement novel twelve years ago, when it was first introduced, and are the patents issued covering the product, as well as the details and methods of construction, valid?

The Lincoln Park Commission of Chicago recognized the novelty of the invention in 1906 when it contracted for Bitulithic pavement on Sheridan Road, and the South Park Commission and its engineers did the same a year later, by the making of important contracts (aggregating 73,171 sq.yd.) for Bitulithic pavement with Warren Brothers Co. and the Chicago Bitulithic Co.

After this recognition of the patents, the South Park Commissioners let a contract to the Metropolitan Construction Co. for a pavement in which the *contractors were required to indemnify the city* against damages to the patentee for *infringement*. Subsequently by municipal construction the South Park Commissioners laid infringing pavements.

It is further worthy of note that the Chief Engineer who now attacks the Bitulithic patents acknowledged their novelty six years ago after a very thorough investigation, and that the experience he has gained in the construction of pavements made of crushed stone and bitumen grew out of the laying of Bitulithic pavements. While he now theorizes that a mixture depending on the asphalt cement for "stability" of the surface (as in the case of asphalt sheet pavement—mortar mixture) is equal to the "inherent stability" of the aggregate provided by the Warren patents, it is a significant fact that in his *practice* he uses a mixture in strict accordance with the principles of those patents providing, as he says, "mortar to fill the voids" (in the coarser stone) with "the fine material in the mortar in proper proportions to give a well filled mixture." This is merely another but less detailed way of saying (quoting from claim 11 of the Warren basic adjudicated patent No. 727,505):

> A mixture of mineral or wearing ingredients of several grades, the ingredients of the descending grades in size and quantity being so proportioned to each other and to the voids existing in the larger grades as fill the voids and impart to the structure inherent stability in combination with bituminous cement or binder.

Other claims in the patent specifically cover such a mixture of mineral aggregate of varying sizes having voids or "space" between the aggregate of "less than 21% of the whole and the plastic binder occupying that space."

The statement is made that in laying a *thinner surface* a somewhat finer mixture (*i.e.*, smaller maximum sized mineral aggregate) was used by Warren Brothers Co. than in other cases where a thicker surface was used, and the quite unjustified insinuation is made that the finer mixture was contrary to the patents. The fact is that the patents are not at all limited to maximum-sized stone except that it shall be "larger than one-fourth (¼) inch in diameter" (i.e., larger than the "grit" found in ordinary sand previously used in asphalt sheet pavement mixtures), and that such "coarse aggregate" shall be used combined with "fine aggregate" (i.e., sand or crusher screenings) in such proportion as to provide "inherent stability" and "less than 21% voids," these being very important properties entirely novel, which form the basis of the Warren patents and the Bitulithic pavement.

Naturally the less the depth of the wearing surface the smaller the maximum-sized aggregate which can be properly used. The rule is that the coarsest particles of aggregate should equal in diameter about half the depth of the completed and compressed wearing surface. The fact is that the very first Bitulithic pavement, laid under the Warren patents (Park Place, Pawtucket, 12 years ago) had a depth of wearing surface of 1½ in. laid over an old tar concrete pavement as a foundation, to which foundation the Bitulithic surface united perfectly, and the maximum sized stone used was ¾ in. In later pavements having standard 2 in. depth of surface, the maximum-sized stone used has been about 1 in. to 1¼ in. in size.

If the Chief Engineer were entirely fair he would have said that everywhere that pavements laid with the special plant and special so called "asphalt" which he so highly lauds have been subjected to "mixed" traffic (i.e., unrestricted combined horse-drawn and automobile traffic) the work has failed in less than a year, to wit, on two intersections on Michigan Boulevard between Jackson St. and 12th St.; on Jackson Boulevard, from Franklin St. to the bridge over the Chicago River, and the lower end of Michigan Ave., between Jackson Ave. and the bridge.

Referring particularly to Chicago patent litigation, the only case which has been brought there, entitled Warren Brothers Co. vs. Metropolitan Construction Co. and the South Park Commission, was necessarily dropped because the contractor acknowledged the validity of the patent and took out a license for its use. As the contractor had indemnified the Park Commissioners, the release of the contractor necessarily included release of the Commission on the contract involved and release of the joint bond of the contractor and Commissioners which had been required by the court.

It is of passing interest that on account of the low prices at which the Metropolitan Construction Co. took contracts, it went into bankruptcy after two years' existence, its creditors receiving 25c. on the dollar and the stockholders losing the whole of their quite large investment.

Subsequent to the Chicago settlement referred to above there was begun and is still pending an action (Warren Brothers Co. vs. Kenosha, Wis.) in the same circuit of the United Statese Court as Chicago, in which case a preliminary injunction was secured. Evidently under advice of council, the city subsequently abandoned the admitted infringing construction and the street was constructed with a different type of pavement. The owners of the patent are pressing their right to continuation of this case to a final issue, thus avoiding the loss of time and expense of carrying the case through several years' preliminary litigation. The patent counsel in the Kenosha case (being also patent counsel of the Chicago South Park Commission) is using every technicality known to the law to delay and prevent this case being tried in court "on its merits" and has even announced that rather than allow such trial he will permit the plaintiff to take a final judgment "in default" against the defendant. In the interests of the public and Warren Brothers Co., the duplicating of another expensive case in Chicago or elsewhere in the same circuit is being deferred while the Kenosha case is pending.

The statement "it has been the policy of the patentees not to push any case to a conclusion where the preliminary rounds have been against them" is absolutely unjustified. The fact is that the Owosso case referred to above, in one of the most stubbornly contested cases of patent litigation on record, involving a record of over 2000 printed pages and five years of active expensive litigation, was lost by the patentees in the lower court and was won in every point both as to validity of patent and fact of infringement in the United States Circuit Court of Appeals, Sixth Circuit, from which decision an application for the writ of certiorari was denied by the United States Supreme Court after full argument and with the 2000-page record before the Supreme Court.

Warren Brothers Co. has no quarrel with any who wish to use any form of pavement which does not infringe upon its patents. It does not desire patent litigation, and only resorts to it when necessary to protect its legal rights, and then only at such times and places and under such conditions as will least interfere with its main business of laying pavements for those desiring its services and consistent with public convenience. Beyond this the company has no fixed "policy" in the matter of prosecutions for infringement of its patents.

WARREN BROTHERS CO.,
By Geo. C. Warren,
President.

59 Temple Place, Boston, Oct. 28, 1913.

NOTES FROM THE ENGINEERING SCHOOLS

PRATT INSTITUTE—The School of Science and Technology of this institute has recently offered an evening course for trade workers who wish to become teachers in vocational schools. This has been done in response to a strong demand for men with trade experience and ability to teach. The fields in which the demand is most marked are the machinist trades, carpentry, cabinet making, pattern making, electrical work, sheet-metal work, printing, drafting, automobile-repair work, plumbing and power-plant operation. Men eligible for this course must be successful journeymen or foremen in some of these trades, less than forty years old and in good health. It is proposed to hold classes on three nights a week, one of which is to be given to actual practice teaching in New York evening trade schools under proper supervision.

RENSSELAER POLYTECHNIC INSTITUTE—Mrs. Russell Sage has presented the sum of $30,000 for the establishment of two graduate fellowships in memory of Russell Sage, 2d, who was graduated at the Institute in 1859 with the degree of Civil Engineer. These fellowships may be conferred upon graduates of the Institute, or of any similar school, who have been distinguished in their undergraduate career for excellence in their work.

The first undergraduate scholarship has been established by Charles Wiggin, of St. Louis (class of '78), with the gift of $7500. A second scholarship has been provided for by a legacy of $10,000, available next year.

U. S. NAVAL ACADEMY—Graduate courses have been developed by the Post Graduate Department for the further training of young naval officers assigned to special lines of duty. The course covers two years; the first being spent at Annapolis and the second at some one of certain prominent schools, or elsewhere in a few instances.

The first year requires the following subjects of all students: Calculus, differential equations, mechanics, physics (lectures and laboratory), chemistry (lectures and laboratory), direct and alternating currents, power plants and machinery (lectures), fuels.

In addition, students specializing in engineering have lectures, recitations and laboratory work in steam machinery and internal-combustion engines. Men specializing in ordinance, study interior and exterior ballistics, elastic strength of guns, chemistry of explosives, etc.

The class which completed the above work last year has been assigned as follows. Students preparing to be naval constructors are at the Massachusetts Institute of Technology following the regular course in naval construction. Those preparing for mechanical engineering are at Columbia University studying thermodynamics, engine and machine design, elevators and conveyors, testing and research methods, metallography, gas-power apparatus, electrical laboratory work, wireless telegraphy and applications of electrical machinery. Students preparing for electrical engineering are at Columbia also, but they give particular attention to direct and alternating currents, experimental laboratory, power transmission, motors and generators, wireless telegraphy, testing and research methods, thermodynamics and metallography, with options of gas-power apparatus and instrument laboratory. Men specializing in wireless signaling follow a similar course but give more time on that particular subject.

The students preparing for ordinance work have been distributed among manufacturers and at the government proving grounds. Men following the electrical course spent the summer at the General Electric Works in Schenectady. Those following mechanical engineering and wireless signaling spent the summer at the New York Navy Yard studying practical matters.

Officers detailed for the Civil Engineer Corps of the navy are sent to the post-graduate school at Annapolis for a four-months' review course, after which they spend two years at Rensselaer Polytechnic Institute. Here during the first year the course covers botany, geology, mineralogy, metallurgy, architecture, structures, stone working, fireproofing, fire protection, mechanics, testing laboratory, mapping, thermodynamics, heating and ventilation, refrigeration, mechanical engineering laboratory, electro-dynamics and electrical laboratory. In the second year the work includes architectural design, law of contracts, railroad engineering, highways, bridges, hydraulics, sewers, water-supply, pumping machinery, internal-combustion engines, compressed air, heating and ventilating laboratory, electrical engineering, power transmission and distribution, electric railways, cranes and elevators, lighting, central-station equipment.

UNIVERSITY OF COLORADO—A one-year course of engineering instruction in public-health work has been established for the degree of Master of Science in Sanitary Engineering and leading to a further course for the degree of Doctor of Public Health. The first course is under the engineering department and is open to engineering graduates versed in elementary bacteriology and in water-supply, sewage and structural engineering. Candidates for the M. S. degree have to obtain full credit in the list of prescribed courses given below and six hours' credit in the secondary courses, the latter being selected to supplement the undergraduate work which may be shown.

PRESCRIBED COURSES

	Semester hours
Advanced bacteriology	5
Hygiene	8
Vital statistics	1
Hydraulic-and sanitary-engineering design	3
Sewage and garbage disposal	2
Thesis (sanitary engineering)	5

SECONDARY COURSES

	Semester hours
Heating and ventilation	2
Electrical engineering	3
Electric lighting	2
Roads and pavements	2
Reinforced-concrete design	2
Water-power engineering	2
Structural-engineering design	3
Water analysis	2
Food analysis	2
Municipal government	3
Statistics	2
Physiology	5

Graduates with the degree of Master of Science in Sanitary Engineering, and students with similar attainments, may complete the second-year course in public health in one year on the same standing as advanced graduates in medicine, except that a certain amount of physiology is required.

A one-year course, leading to the degree of Master of Science in Public Health, is now open for ordinary graduates in medicine. The subjects pursued are shown below.

FIRST SEMESTER

Hygiene—I. Air, soil, water, light, heat, ventilation, plumbing, sewage and garbage disposal. II. Occupational hygiene, disinfection, quarantine, disposal of dead, food and meat inspection, etc.

Advanced bacteriology, including parasitology of diseases of animals transmissible to man, algology.

Sanitary Engineering, water-works.

Social and vital statistics.

SECOND SEMESTER

Hygiene—III. Eugenics, school hygiene, personal hygiene, immunity. IV. Epidemology, infectious diseases.

Sanitary engineering, sewerage.

Food analysis.

Water analysis.

Thesis based on research.

The second year's study for both engineering and medical men, leading to the degree of D. P. H., is largely field and research work, but the following subjects are recommended and may be required: public-health law, public-health problems, municipal government, sociology.

Types of New York State Roads

By W. G. Harger*

SYNOPSIS—There has been much wholesale criticism of New York State Highway work, but, as is generally the case, the fault has been chiefly with the political administrative heads and with contractors having political influence and not with the subordinate engineers in actual charge of the design and construction. This article takes up the classes of pavements adapted to different kinds of traffic requirements, gives cost data and draws conclusions based on several years' experience as to the best method of construction, wear and the economy of the different types of pavement on Division 5, in Western New York State. The paper should be of great value to highway engineers in solving the difficult problem of what kind of pavement to build and where to build it. The paper is a valuable supplement to the article on "Cost Data on Bituminous and Waterbound Macadam Roads," by the same author, in our issue of July 13, 1911, p. 48.

There is always a keen interest in any discussion of the cost and availability of different kinds of improved roads where experience has been long enough to give conclusions weight. Plain and bituminous macadam, asphaltic concrete, Kentucky rock asphalt, brick, concrete, "Amesite," "Rocmac" and vitrified-shale cube pavements have been used on roads in Western New York State since 1908, giving the engineers of the New York State Department of Highways every opportunity to observe their action under different traffic and soil conditions.

The highway work of this state is periodically subjected to destructive criticism, generally for political purposes, which is usually not too closely based on fact. Statements which have been given wide publicity lead anyone not personally familiar with our roads to believe that improvements on them have been failures. This is not so. There have been flagrant abuses of administration, many cases of criminal waste of money, and the unavoidable waste that occurs in any big organization, but the system of roads as built in Division 5 is worth the total expenditure to the people of this section.

The engineers know how to design and to construct according to the most approved practice. The cases of poor design have been due largely to rushing plans, or to either administrative or local insistence on utilizing the product of a favored concern. There have been cases of poor construction, due either to inexperienced inspectors or to the impossibility of controlling favored contractors; but the highway system as a whole is creditable. The weak point up to this time has been the lack of systematic maintenance. Even ordinary macadam roads can be maintained successfully and economically under limited traffic. The administrative conditions need improvement, but the sweeping condemnation and the irresponsible criticism to which the roads themselves have been subjected is not justified.

One criticism which on the surface seems to be correct is that the type of construction has not been flexible enough to utilize to advantage local materials; that where it was found cheaper and as satisfactory to use two or three different types on one contract, only one form was used, resulting in a money loss to the state.

A great many cases of this kind have occurred, for the reason, however, that the designing force found from costly experience that where they used two or more types of construction on one contract it resulted in unbalanced bids; in changes by non-competitive supplementary agreements to the more expensive of the types used and in charges of collusion between engineers and contractors. In self defense they have favored the policy of selecting one type of construction for one contract. The fault here lies with the administration, not with the designers.

The engineers prefer to make careful designs using the local materials provided they are reasonably certain that they will not be discredited by changes during construction. It is my intention to briefly describe these different types considered available in Western New York State.

Under the restrictions which are given below as to traction engines and motor vehicles, adopted by the State Highway Commissioner, and which went into effect Oct. 20, 1913, all of the surfaces mentioned in the first part of this article can be used.

REGULATIONS FOR STATE AND COUNTY HIGHWAYS ADOPTED BY THE COMMISSIONER OF HIGHWAYS OF THE STATE OF NEW YORK.

Sec. 1. No traction-engine, road-engine, hauling-engine, trailer, steam-roller, automobile truck, motor or other power vehicle shall be operated upon or over the state or county highways, the face of the wheels of which vehicle are fitted with flanges, ribs, clamps, cleats, lugs or spikes. This regulation applies to all rings or flanges upon guiding or steering wheels of any such vehicle. In cases of traction-engines, road-engines or hauling-engines which are equipped or provided with flanges, ribs, clamps, cleats, rings or lugs, such vehicles shall be permitted to pass over said highways provided that cleats are fastened upon all the wheels of such vehicles, and are not less than 2½ in. wide and not more than 1½ in. high, and so placed that not less than two cleats on each wheel shall touch the ground at all times, and the weight shall be the same on all parts of said cleats.

Sec. 2. No traction-engine, trailer, steam-roller, automobile truck, motor or other power vehicle shall be operated upon or over the state or county highways; nor shall any object be moved over or upon any such highways upon wheels, rollers or otherwise, in excess of a total weight of 14 tons, including the vehicle, object or contrivance and load, without first obtaining the permission of the State Commissioner of Highways as hereinafter provided. No weight in excess of 8 tons shall be carried on any one axle of any such vehicle.

Sec. 3. The tire of each wheel or a traction-engine, road-engine, hauling-engine, trailer, steam-roller, automobile truck, motor or other power vehicle (except traction-engines, road-engines and hauling-engines) shall be smooth, and the weight of such vehicle, including load, shall not exceed 800 lb. upon any inch in width of the tire, wheel, roller or other object, and any weight in excess of 800 lb. upon an inch of tire is prohibited unless permission is obtained from the State Commissioner of Highways as hereinafter provided.

Sec. 4. No motor or other power vehicle operated upon any state or county highway shall be of a greater width than 90 in., except traction-engines which may have a width of 100 in.

Sec. 5. No traction-engine, road-engine, hauling-engine, trailer, steam-roller, automobile truck, motor, or other power vehicle, carrying a weight in excess of 4 tons, including the vehicle, shall be operated upon any state or county highway at a speed greater than 15 mi. per hr.; and no such vehicle carrying a weight in excess of 6 tons, including the vehicle shall be operated upon any such highway at a speed greater than 6 mi. per hr. when such vehicle is equipped with iron or steel tires, nor a speed greater than 12 mi. per hr. when

*16 Hindsdale St., Rochester, N. Y.

the vehicle is equipped with tires of hard rubber or other similar substance.

Sec. 6. The State Commissioner of Highways, upon proper application in writing, may grant permission for the moving of heavy vehicles, loads, objects or structures in excess of a total weight of 14 tons over state and county highways, upon proper application in writing being made therefor, and under such restrictions as the Commissioner may prescribe.

Sec. 7. The owner, driver, operator or mover of any vehicle over any state or county highway shall be responsible for all damages which said highway may sustain as a result of a violation of any of the provisions of the foregoing Rules and Regulations, and the amount thereof may be recovered in an action of tort by the State Commissioner of Highways or by any County Superintendent of Highways of any county or by any Town Superintendent of Highways of any town in which said violation occurs.

Sec. 8. These regulations take effect October 20, 1913.

"Section 24 of Chapter 25 of the Consolidated Laws entitled 'The Highway Law' provides that any disobedience of any of the foregoing rules and regulations shall be punishable by a fine of not less than $10 and not more than $100 to be prosecuted by the Town, County or District Superintendent, and paid to the County Treasurer to the credit of the fund for the maintenance of such highways in the town where such fine is collected."

Classification of State Highways

Roads in this territory can be divided on a traffic basis into four classes.

(1) Main feeder roads which extend from 10 to 15 miles out of cities like Rochester and Buffalo and in the business sections of villages and third-class cities, which carry the concentrated garden truck traffic of a large area, and are subjected to continuous auto-truck and touring-car traffic.

(2) Main through automobile routes at a greater distance from the cities which have a large touring-car traffic and a medium heavy farm-produce traffic.

(3) Secondary feeder roads and cross roads having a medium and light farm traffic and light automobile traffic.

(4) Pleasure roads or scenic routes that have a heavy touring-car and light steel-tire traffic.

For Class 1 we have had the best success with a brick surface on a concrete base, using either Hillside brick or stone block on grades of 5% or higher. We consider this to be the most economical construction in the end.

For Class 2 the first choice is a grouted bituminous macadam, which seems to be most economical in the long run. The economies in this type of construction are largely confined to selecting the cheapest type of suitable foundation course.

The second choice is a waterbound-macadam surface treated with a surface coat of refined tar of the binder grade and maintained with periodical applications of cold refined tar. The indications are that in the near future the vitrified-shale cube surface will be able to compete economically with bituminous macadam for roads of this class. "Amesite" and "Rocmac" are satisfactory but are usually rejected on account of a slightly higher first cost. "Amesite" particularly is a promising material.

For Class 3 waterbound macadam treated with heavy refined tar and maintained with cold refined tar, or waterbound macadam treated with a light coat of No. 3 or No. 4 road oil once a season, or waterbound macadam treated two or three times a season with calcium chloride gives the best satisfaction.

For Class 4 grouted bituminous macadam, concrete with or without a protecting bituminous surface, or waterbound macadam with "Tarvia A," asphaltic concrete, "Amesite" or "Rocmac" gives good results.

Cost Data on Different Kinds of Road Surfacing

The average costs of the different pavements on Division 5 for 1912 and 1913 have been as follows. There is a wide range of cost for each type on different roads and it is understood that the general costs as given are not reliable as a basis of selection for every road. These costs do not include engineering expenses. Detailed cost data may be found in a previous article in Engineering News.*

Average cost of items other than metalling on all kinds of roads in Division 5

Excavation, per mile	$2100
Drainage structures, per mile	700
Minor items such as guard-rail, cobble gutters, drives, etc, per mile	600
	$3400

Cost of standard types of pavement: brick on concrete foundation

Average cost per mile, 16-ft. width of brick, 5-in. concrete base, 6-in. edging: $21,000 for pavement + $3400 for other items = $24,400 per mile, divided as follows:

	Per cent. of total cost	Cost per mile
Excavation	9.0	$2,200
Drainage structures	2.8	700
Foundation and sub-base	25.9	6,300
Surfacing and edging	60.1	14,700
Minor points	2.2	500
	100.0	$24,400

This pavement costs $1200 per mile per foot of width.

Cost of asphaltic concrete on concrete base

Average cost per mile, 16-ft. width of asphalt, 1½ in. thick, 5-in. concrete base and 6-in. concrete edging: $16,500 for pavement + $3000 for other items = $19,500 per mile, divided as follows:

	Per cent. of total cost	Cost per mile
Excavation	9.9	$1,900
Drainage structures	3.6	700
Foundation and sub-base	33.0	6,400
Surfacing and edging	51.6	10,100
Minor points	1.9	400
	100.0	$19,500

This pavement costs $1000 per mile per foot of width.

Cost of bituminous macadam surface on either macadam, fieldstone or gravel bottom course, depending on the local materials and soil conditions

Average cost per mile, 16-ft. width: $9200 for pavement + $3100 for other items = $12,300 per mile divided as follows:

	Per cent. of total cost	Cost per mile
Excavation	15.9	$1,900
Drainage structures	5.3	700
Foundation and sub-base	27.0	3,300
Surfacing	47.5	5,900
Minor points	4.3	500
	100.0	$12,300

This pavement costs $575 per mile per foot of width. Waterbound macadam generally costs about $2000 per mile less than bituminous macadam. Waterbound macadam treated with a surface coat of refined tar costs approximately $11,300 per mile or $1000 less than a grouted bituminous macadam.

Concrete roads with a thin protecting bituminous surface

The concrete roads built in this vicinity have been made generally of pit-run local gravel concrete and cannot be considered as first-class examples of the type. Their cost per mile of 16-ft. width and 6-in. thickness of concrete with a ⅝-in. bituminous wearing coat has averaged $8100 for pavement + $4400 for other items = $12,500 per mile, divided as follows:

*Engineering News, July 13, 1911, article by same author.

	Per cent. of total cost	Cost per mile
Excavation	18.0	$2,300
Drainage Structures	7.2	900
Foundation and sub-base	56.0	7,000
Surfacing	10.0	1,300
Minor points	8.8	1,000
	100.0	$12,500

This pavement cost $500 per mile per foot of width. A first-class concrete road made of stone concrete would cost on an average for this territory about $9500 to $10,000 per mile for the pavement, or about $600 per mile per foot of width.

"Amesite," Kentucky rock asphalt, "Rocmac" and cube surfaces have been laid but not on sufficient mileage to generalize the cost.

The following tabulation and explanatory report made Sept. 17, 1913, give a very good idea of the average cost of all roads in different parts of this division. These items are based on estimates for roads ready for advertising in 1914. Undoubtedly, a number of these designs will be changed to an advantage before letting.

County	Miles	Estimated cost including engineering	Average cost per mile
Allegany	38	$596,000	$15,700
Cattaraugus	25	449,000	18,000
Chautauqua	25	486,000	19,400
Erie	15	432,000	28,800
Genesee	10	145,000	14,500
Livingston	6	73,000	12,200
Monroe	35	464,000	13,300
Orleans	23	316,000	13,700
Niagara	23	363,000	15,800
Wyoming	16	255,000	15,900
Totals	216	$3,579,000	

The cost in Allegany County is a little high, considering the character of the traffic. Roads are of necessity more costly in this county for good material is scarce and grading is heavy. Some saving can be made by a reduction of width. In Cattaraugus and Chautauqua Counties the highway work is expensive, for here also road material is scarce and the grading heavy. Some saving can be effected by narrowing widths and the substitution of gravel or field-stone sub-base bottom under bituminous macadam or waterbound macadam with a bituminous flush coat top for some of the brick roads.

Erie County is not, in my opinion, entitled to such uniformly expensive construction, although it is normally entitled to a higher cost per mile than the other counti as the traffic is extremely heavy near Buffalo. In Ger see County costs are fair. The roads in Livingston, Mo roe and Orleans Counties are well designed. The sam may be said of Niagara County, where the average raised by two brick streets in cities. In Wyoming Count

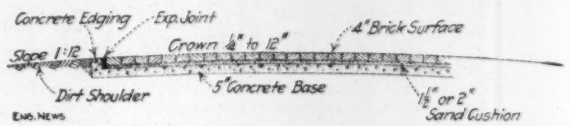


FIG. 1. NEW YORK STATE HIGHWAY DEPARTMENT BRICK ROAD CONSTRUCTION

the cost is high, considering the locality and types of pavement used.

The mileage of the different types of pavement as designed, are as follows:

	Miles
Brick	40
California sheet asphalt	2
Rock asphalt	4
"Hassam" (concrete)	16
Concrete bituminous top	21
Bituminous macadam	129
Waterbound macadam	4
	216

It does not seem safe to build any more concrete roads with thin bituminous tops until there has been more opportunity to observe the wear of the roads already built. All roads designed for this type could be changed to some form of bituminous or waterbound macadam with bituminous flush coat at the same or less cost. The "Hassam," rock asphalt and sheet asphalt types can be eliminated with a resulting reduction in cost; and some of the brick pavement can probably be changed to another type with advantage.

Most of the brick, bituminous macadam and waterbound macadam designs will probably stand without correction, except possibly for widths. The present practice of designing these types with suggested modifications is as follows:

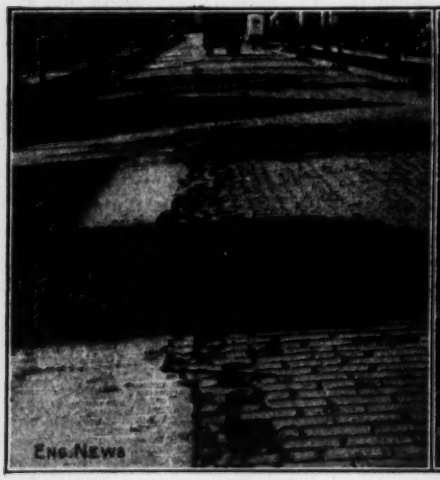


FIG. 2

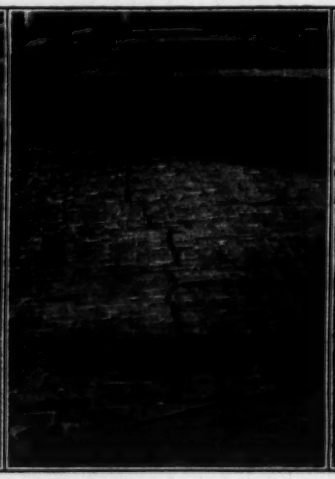


FIG. 3

FIG. 4

Fig. 2. Result of wear in a longitudinal crack; pavement laid in 1908; photograph taken Oct. 22, 1913.
Fig. 3. Typical longitudinal crack in curbed street; cracks usually occur close to crown; pavement built in 1908; cracks developed in 1909 and 1910; photograph taken Oct. 22, 1913.
Fig. 4. Loosening and wear at transverse expansion joints; these transverse joints no longer used in New York State roads; pavement built in 1909; photograph taken on Oct. 22, 1913.

DEFECTS IN NEW YORK STATE BRICK ROADS

Practice in Pavement Design

Brick on a Concrete Base—This form of construction (Fig. 1) has been used both for new roads and for resurfacing old macadam on which the travel was too heavy. A modification of the base using an average thickness of concrete of only 3 in. to even up the macadam base has been used for resurfacing jobs, but is not considered a safe design.

As stated in the first part of the article, brick is the most available type for our heaviest traffic roads, but it has the bad features of any rigid construction (see Figs. 2, 3 and 4). Longitudinal cracks develop due to heave under frost action or settlement on new fills. The pavement is a difficult form to repair if anything goes wrong. The life of the surface is doubtful, probably lying somewhere between 15 and 25 years.

The longitudinal cracks have been carefully studied as they are the most discouraging feature. They always occur within two or three feet of the center on our country roads and generally extend down through the concrete foundation. Fewer cracks develop as the crown becomes less. From these facts Wm. C. Perkins, former Resident Engineer, was led to experiment with a concrete base, flat on the bottom, crowning the road by making the base thicker in the middle (see Fig. 5). Apparently, this

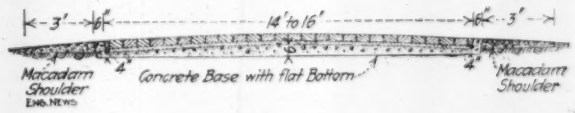


Fig. 5. Proposed Change in Brick Road Foundation

form of base reduces the number of longitudinal cracks. A depth of sand cushion of ¾ in. or 1 in. in thickness is considered better practice than the present depth of 1½ to 2 in. Careful inspection is required for this type.

Asphaltic Concrete on a Concrete Base—This type (Fig. 6) has not been entirely successful; a 1½-in.

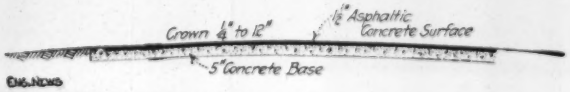


Fig. 6. Asphaltic Concrete on a Concrete-Base Construction

thickness is evidently not enough, for holes develop rapidly (see Fig. 7). It is probable that 1½ in. obtained uniformly is enough, but practically it is impossible to prevent less thickness in places due to inequalities of the concrete base and additional compression under heavy traffic. For this reason a 2-in. thickness is preferred, but this makes the pavement cost as much as brick. However, it cannot compete economically with brick for our purposes. The pavement makes a beautiful looking road but gives a poor footing for horses, and on it automobiles skid easily. It should not be used on grades of over 3½% and is a poor design on roads having much team traffic.

Grouted Bituminous Macadam—This type is available for a large percentage of roads in our section. The variations of the foundation courses offer the best chance for economy of design by utilizing local materials.

Where local hardhead rocks of fairly good quality suitable for crushing are plentiful and the foundation soil is good, a crushed-stone macadam bottom course, strengthened for short strips of bad foundation soil with field stone sub-base, is the most satisfactory (see Fig. 8).

With the same rock materjal where there are stretches of bad foundation soil a sub-base bottom course of field stone filled with gravel or stone chips, or a coarse gravel bottom course ranging in thickness from 6 to 12 in., is the most economical and satisfactory (see Fig. 9). A field-stone bottom course is not recommended for good

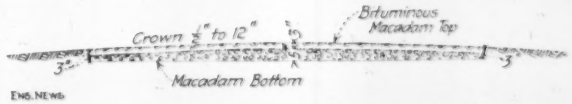


Fig. 8. Bituminous-Macadam Top on Macadam Bottom Course Where Soil Is Sand, Gravel or Light Loam

foundation soils, even if it can be placed as cheaply as a macadam bottom, because it is more difficult to place the top course on it evenly and get a smooth riding road.

Where a road follows a creek or river containing bars of coarse gravel or where the local supply of coarse pit gravel is plentiful, a pit- or bar-run gravel bottom course

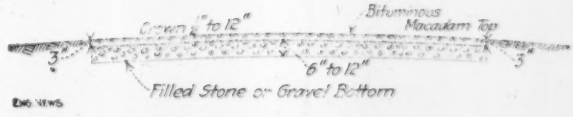


Fig. 9. Bituminous-Macadam Top on Field Stone or Gravel Bottom Course Where Foundation Soil Is Poor

4 to 8 in. thick has proved perfectly satisfactory under medium traffic, but not under heavy traffic.

The thickness of the top course is economically impor-

Fig. 7. Showing Character of Failure of Asphaltic Concrete Surface Originally 1½ In. Thick, under Heavy Traffic; Pavement Built in Fall of 1911, Photograph Taken Oct. 22, 1913

tant, particularly if imported stone is required. It has been found from experience that a 2-in. bituminous macadam top is too thin on account of constructional difficulties. A 2½-in. thickness is successful when laid on a macadam base, but a 3-in. thickness is required where laid on a field-stone or gravel foundation. A 3-in. thickness is also advisable where the stone is crushed locally, as it allows the use of a slightly larger grade of stone, which cheapens the crushing cost. It has therefore been found economical to use a 2½-in. thickness of top course (Fig. 10), where the local stone was suitable for macadam bottom course and expensive imported stone was required for the top. A 3-in. thickness is better for all other conditions.

The size of the stone used for the top course is an important feature. Notwithstanding the experience we have had, the specifications* continue to call for either

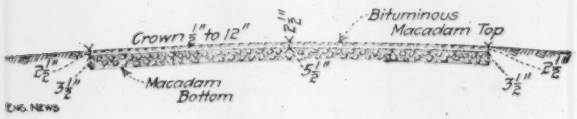


FIG. 10. BITUMINOUS-MACADAM TOP OF IMPORTED STONE, WHERE LOCAL STONE CAN BE USED FOR MACADAM BOTTOM COURSE

too small stone (an average of about 1 in. in size) or for a mixture of 1-in. and 2-in. stone. The first size is not practical as it prevents an even pour of the bitumen and does not stand up as well under heavy loads as a larger size; and the second size, while theoretically all right, does not work out in practice. The two sizes are separated in spreading, forming pockets of fine and pockets of coarse stone, which not only prevent an even pour but wear differently.

The best success has been obtained as follows: Stone ranging in size from 1¼ to 2½ in. is spread and rolled, the bitumen is then poured; a thin layer of ¾-in. stone spread over the surface and rolled into the voids of the coarse stone. The following day, the road is rolled till well shaped and the excess ¾-in. stone is then broomed off and a wearing coat of screenings spread, if a single-pour road; or a flush coat of bitumen poured and covered with screenings if a flush coat is desired.

The experience on this division indicates that for a 3-in. course 1.75 gal. of bitumen per sq.yd. is about right; and for a 2½-in. course 1.5 gal. per sq.yd. Our experience also indicates that better success is obtained by pouring the bitumen used as binder in the body of the course by hand transversely to the road (Fig. 11) than by the use of pressure-machine spreaders; but better success is obtained by the use of pressure-machine spreaders for a surface coat.

The residuum bitumens have been satisfactory for binder but are not so successful for surface coats as either the natural asphalt products or refined tars.

A single-pour bituminous-macadam road gives a good footing on grades up to 8% and a safe surface for motor travel, as it is rough enough to give a good grip (Fig. 12). It also is generally a smoother riding road than where a flush coat is used; I favor a single-pour construction. A flush coat should not be used on grades above 5%.

Bituminous-macadam pavements have two serious disadvantages. They require unusually intelligent and conscientious inspection; and they cannot be built late in the season. The indications are that a well built bituminous road, under the class of traffic for which it is recommended, can be maintained by the application of a light coat of No. 4 standard road oil or a cold refined tar applied by a pressure sprayer the 2nd and 3rd or 3rd and 4th years; a coat of bitumen of the binder grade and a ¾-in. stone coating the 4th or 5th year, and recapping the 6th or 7th year. On this basis it is an economical construction.

FIG. 11. POURING BITUMEN BY HAND TRANSVERSELY TO ROADWAY

FIG. 12. TEXTURE OF SURFACE OF GROUTED BITUMINOUS MACADAM BUILT IN 1910

(Photograph taken Oct. 22, 1913; no repairs to date; 1.75 gal. of residuum asphalt binder per sq.yd., poured in one coat; top stone, 1½ to 2½ in.)

WATERBOUND MACADAMS WITH REFINED TAR SURFACE COAT—Economics in these designs are limited to variations in the foundation courses. The same types of foundations used for bituminous macadam are available.

A top course 3 in. thick has been found to be the most successful and economical. It is constructed either as the usual waterbound macadam, or the voids can be filled with coarse sand in place of screenings. The surface is then broomed off clean till the filler or screenings are removed to depth of ¼ to ½ in. below the top of the

*New specifications are in preparation which may remedy this fault.

larger fragments, and a heavy refined tar applied hot at the rate of from 0.4 to 0.8 gal. per sq.yd. A layer of ¾-in. stone is immediately spread over the surface and thoroughly rolled.

The best example of this kind of construction in this division is the West Side Boulevard built by the County of Monroe in 1908 (Fig. 13). This road has been maintained by the use of "Tarvia X" and ¾-in. stone as a repair for holes that develop, and by periodical applications of a cold refined tar to keep the surface in condition. The road is in as good condition today as when first built five years ago.

MAINTENANCE COST OF WATERBOUND MACADAM WITH REFINED TAR SURFACE COATS

Constructed 1908		
Maintenance	1909	
	1910	$4,150.00
	1911	4,184.00
	1912	2,500.00
	1913	2,600.00

Average cost of $0.058 per sq.yd. per year.

This type of construction requires more continuous maintenance than the grouted bituminous macadam, but if systematically maintained is an economical road.

Under comparatively light traffic, a plain waterbound macadam treated with No. 3 or No. 4 road oil or cold refined tar is a good type. If this construction is used, however, the oil should be applied by pressure machines using not over 0.3 gal. per sq.yd., and the oil should be applied in June to avoid the disagreeable oily mud that is encountered during the fall and spring rains.

FIG. 13. WEST SIDE BOULEVARD, MONROE COUNTY, BUILT IN 1908, PHOTOGRAPH TAKEN OCT. 14, 1913, SHOWING ALSO CONCRETE GUARD-RAIL CONSTRUCTION

CONCRETE ROADS—The concrete used in these roads (Figs. 14 and 15) has been either a 1:2½:5 stone concrete or a local pit-run gravel mixed 1:6. The use of the 1:6 gravel concrete is universally condemned. A stone or screened gravel concrete mixed 1:2:4 is advocated for future work.

The engineers of this division are not generally in favor of concrete road construction. It is difficult to make these roads smooth riding even when first built. While they are less liable to rut than macadam construction, they crack badly under frost action and under settlement of new fills and are hard to repair.

Concrete is not a reliable material as a road surface when the traffic comes directly upon the concrete, and it is difficult to successfully protect the surface with a skin coat of bitumen, particularly where there is much heavily loaded steel-tire traffic. The type has not yet been tested to a conclusion; it may show up better than we expect, but until that time it is not considered available for many of the roads.

FIG. 14. PRESENT PRACTICE OF CONSTRUCTION OF CONCRETE WITH BITUMINOUS WEARING COAT

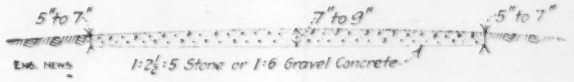


FIG. 15. PROPOSED CHANGE IN CONSTRUCTION OF CONCRETE WITH BITUMINOUS-WEARING COAT

KENTUCKY ROCK ASPHALT has not been uniformly successful in this division. We have some good examples and some complete failures. The type is available for Class 3 traffic; but it is generally rejected on account of costing more than bituminous or tarred macadam.

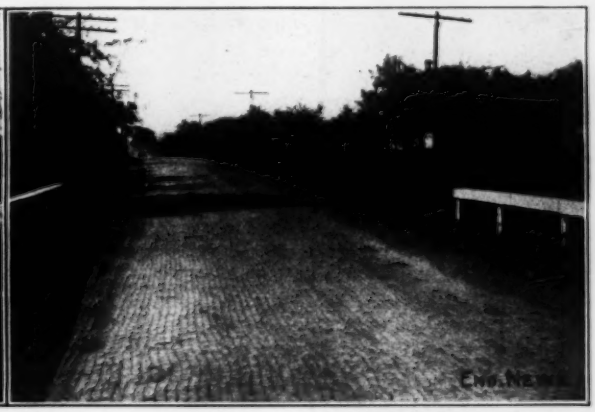


FIG. 17. VITRIFIED-CLAY CUBE ROAD BUILT ON MACADAM BASE WITH SAND FILLED JOINTS IN 1909

"AMESITE" AND "ROCMAC" are particularly available for resurfacing. They are suitable for Class 2 and Class 4 traffic but have not been much used as they are patented products and are more expensive than bituminous macadam.

VITRIFIED CLAY CUBE SURFACING—Little more can now be said for this type than that it is very promising. It is not unlikely that it will be used extensively in the near future for roads under Classes 2 and 3, and possibly for Class 1. Fig. 16 shows the method of construction and Fig. 17 shows a surface that has been in use 5 years under Class 2 traffic. A number of articles have appeared in the engineering papers describing the cube pavements of Monroe County.*

*See Engineering News, Feb. 2, 1911, p. 128.

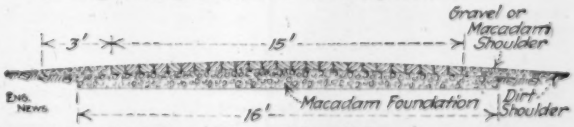


FIG. 16. VITRIFIED-CLAY CUBE ROAD CONSTRUCTION

Conclusions

The cost of a road system can be greatly reduced by the proper selection of the most economical and suitable type of construction for each separate road.

The width of pavement is an important factor. The roads of Division 5 almost uniformly use 16 ft. of metalling with a graded section from 26 to 32 ft. I personally believe that provided the grading is kept the same width as for a 16-ft. road, in a great many cases, the metalling can be reduced in width to 12 or 15 ft., using gravel or loose stone on the shoulders, which can later be widened if needed.

With a proper selection of width and type, the average cost of the balance of the roads in the state system in the counties under discussion will probably be between $14,000 and $16,000 per mile.

❋

The Arnold Report on the Chicago Railway Terminal Situation

Within the past few weeks two very important reports have been made on the railway terminal situation in Chicago. One by John F. Wallace, to the council committee on terminals, was given in abstract in our issue of Nov. 6. A more comprehensive report has been made since then by Bion J. Arnold, at the instance of a special committee of citizens, which has submitted the report to the above council committee. An abstract of this report is given below.

For the benefit of our readers we may explain that these reports result from the application of the Pennsylvania R.R. for authority to reconstruct the old Union Station practically on its present site and to build a freight station in a new location. This opened up the question of improving the complicated and ill-arranged railway terminal system of Chicago, which at present is a serious obstacle to proper commercial development of the city. The general situation is shown on the accompanying map. Instead of the present six stations, Mr. Arnold would have three (shown at *A*, *B* and *C*), two of which would be union stations. Another union station *D*, might be provided, but this represents the maximum number that should be allowed.

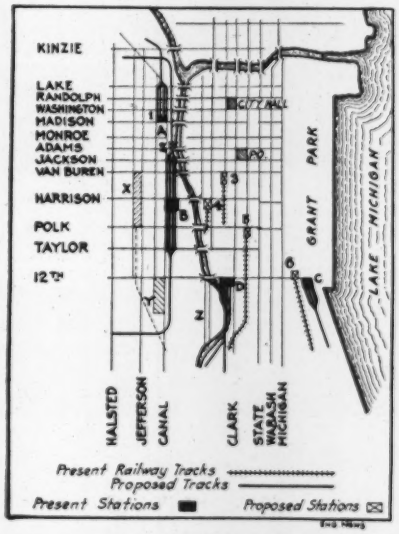
ELEVATION OF RAILWAY TRACKS

In regard to the elevation and depression of railway tracks through the city, the policy of eliminating street grade crossings by raising the tracks is approved, but it is considered that a serious error was made in permitting the Chicago & Northwestern Ry. to elevate its tracks as far south as its new terminal station on Madison St. This greatly complicates the present situation. Had the city required the company to depress its tracks here (as are the Pennsylvania R.R. tracks at Madison St.), or to terminate its elevated tracks at Lake or Randolph St. (farther north), there would have been no so called Chinese wall of elevated tracks started along Canal St., and the incentive to continue it would now be lacking. Had the policy been adopted of depressing these tracks, as well as all other tracks between Canal St. and the river, there would have been created a depressed railway route parallel to the axis of the city, to which no serious objection could be offered.

NUMBER AND LOCATION OF STATIONS

Assuming the city as it now is, but without any of the present passenger terminals, the best practicable plan (on the assumption that the railways would coöperate with the city) would be to have two main terminals. One on the site of the Illinois Central station at 12th St. and the lake front, and the other at 12th St. west of the river, these being supplemented by smaller stations to the north and south for suburban traffic. These would have through tracks on the low level and stub tracks on the upper level (the latter at the level of the 12th St. viaduct). With provision for 40 tracks on each level, as an ultimate expansion, these would take care of the main-line passenger business for almost an unlimited period.

If Chicago maintains the same rate of growth in railway business as the entire country, its passenger train movement is likely to increase as the square of the population of the entire country within the same period. The passenger traffic will likely increase as the cube of the population of the entire country.



Present Railway Terminal Stations (all except No. 1 are used by several roads).
1. Chicago & Northwestern Station.
2. Union Station (which Pennsylvania R.R. proposes to rebuild on same site).
3. La Salle Station.
4. Grand Central Station.
5. Dearborn Station.
6. Illinois Central Station (to be rebuilt on site marked C.)

Railway Terminal Stations Proposed by Mr. Arnold:
- A. Chicago & Northwestern Station (unaltered).
- B. Union Station (in new location).
- C. Illinois Central Station (in new location).
- D. Possible future station, if necessary.

New freight station and elevated approach proposed by Pennsylvania R.R., but disapproved by Mr. Arnold.....X
New freight station built recently by the M., St. P. & S. S. M. Ry.....Y
River straightening proposed by Mr. Arnold .....Z

Plan of Railway Passenger Terminals at Chicago, as Proposed in Report of Bion J. Arnold

A single union passenger station on the Illinois Central site, having 29 stub tracks on two levels, with suitable through connecting tracks, would take care of the entire passenger traffic of the city (including all the suburban business) for about seven years. If the suburban business were eliminated, this station would take care of all of the main-line through traffic of the city for about 28 years. If a similar new station of about the same capacity were constructed at some other point, these two stations would take care of the combined passenger traffic of the city for about 32 years, and of the main-line through traffic, exclusive of suburban, for about 50 years. On the assumption that the Chicago & Northwestern station would take care of its own traffic, these two stations would accommodate all of the through and suburban traffic of the city (except the Northwestern, for about 40 years; and all through traffic, except suburban traffic, for about 55 years.

A single-berth through station or a double stub-end sta-

on has the greatest capacity for a given investment, provided it is properly located so as to be easily accessible and designed as to be able to utilize the tracks at each end upon the reservoir principle. That is, when the outbound traffic is heaviest, as is usually the case in the evening, most of the tracks could be used for outgoing trains, while the reverse takes place in the morning. This is accomplished in a stub-end or a straight-away through station, by having all of the tracks converge into two or more lead tracks.

This principle is not obtained with a station divided into separate parts, one having exclusively inbound and the other exclusively outbound tracks. Furthermore, a given number of stub or through tracks located in one station would handle more traffic than the same number of tracks located in several stations, due to the fact that there must be in any station a certain margin of reserve tracks. But this margin could be proportionately less as the size of the station increases and the number of stations decrease.

This emphasizes the correctness of the principle accepted by Jarvis Hunt and others, that a single station would be the most economical to construct and operate; consequently the number of stations should be kept as few as practicable. Unfortunately, the Hunt plan,* ingenious and comprehensive as it is, did not possess this interchange or reservoir principle, and was so located as to constitute an obstruction to the extension of the business district. Further, it would require changing the location of every passenger station and many of the principal freight stations in the city, which while advantageous in many cases does not seem necessary in all cases.

Were it advisable to adopt a single station for Chicago, its logical location would be at the terminal of the Illinois Central R.R. at 12th St., where ample capacity to the eastward could be obtained for extension, and no streets would be obstructed. But the difficulties in getting all of the railways to agree to occupy such a station (especially those from the west side of the river) make this plan impracticable.

Similarly, the plan of locating a group of unit stations in one particular locality, as advocated by Pond & Pond and Guenzel & Drummond,* meritorious as these plans are in many respects, becomes impracticable for the same reason; namely, that there is a logical and natural division between the different railways of the city, as determined by their geographical location and the serious practical obstructions caused by the Chicago River.

For these reasons, and from the fact that the new Northwestern station is already located, and will undoubtedly be used for many years to come, and the fact that the Illinois Central R.R. has such a desirable location for a station, I am forced to the conclusion that any plan contemplating less than three stations now, with the possibility of more later, would be impracticable. Therefore suitable provision could and should be made for the construction of a new passenger terminal station, as now contemplated by the Pennsylvania R.R. and its associates.

The question of the location of such a station is the important one, and it seemed to me best to revert to the fundamental idea set forth by Mr. Durham in his "Plan of Chicago" issued by the Commercial Club in 1909, wherein he recommended unit stations located along Canal St., using either elevated or depressed tracks. My recommendations, however, are not alternative but are absolutely for depressed tracks in this particular locality, for such stations can be located upon the low land contiguous to the river, which forms a natural location for railway terminals, and is now occupied almost exclusively for this purpose.

LOCATION OF THE PENNSYLVANIA R.R. STATION (UNION STATION)

The location of a passenger terminal for the Pennsylvania R.R. and its associated roads on Canal St., south of 12th St., is not impracticable. But it would be unfair to force such a location upon the Pennsylvania R.R. unless other competitive roads and those other roads now having passenger stations north of 12th St. agree to join it in a new station or to enter the Illinois Central station on the lake front, for the reason that such enforcement would compel the Pennsylvania R.R. to give up its present advantageous location.

Furthermore, it is not clear that the interests of the city would be served best by moving the Pennsylvania and its associates south to 12th St. If the Pennsylvania R.R. would locate its passenger station with the head house just south of Harrison St., its interests would be fully conserved.

There should be no serious objection or opposition to allowing the Pennsylvania and associated companies to build their passenger terminal at Adams St.; provided (1) that the ordinance authorizing its construction carries with it no rights to construct freight terminals; (2) that these companies are bound by contract ordinances to carry out the suggestions with reference to a future relocation of the terminal; (3) that they agree to coöperate in the straightening of the river, and (4) that they pay to the city (in cash or improvements) an equivalent to the value of the property vacated.

*These plans were described in our issue of July 31.

STRAIGHTENING THE RIVER

The most important improvement for the benefit of the city and the railways would be the straightening of the Chicago River from Harrison or Van Buren St. By this change, drastic as it may seem, the entire congested district south of the present business district, and now occupied by railway terminals, could be opened up. Then the freight terminals could be rearranged in such a manner as not only to improve conditions for handling freight, but to make possible the construction of business blocks upon the sites of the present terminals, with the advantages of railway terminal facilities underneath. This is somewhat on the principle of the facilities now underlying the large district north of the Grand Central terminal station in New York City.

While this class of improvement practically necessitates the electrification of the tracks, the suggestion is not made with the intention of attempting to force this, for most progressive steam railway men now recognize that electrification of terminls must come within a reasonable time. It is made only for the purpose of emphasizing the advantage that the railway companies now possess for future development by their ownership of these sites.

The straightening of the river would transfer from the west to the east side of the river, many acres of comparatively cheap property, and cause it to double or possibly treble in value, if properly developed, for it would then become a part of one of the most desirable localities of the business district.

This increase would be from $7,750,000 to $31,290,000, depending upon the location assumed for straightening the river and the relative increase of values assumed. The expense would be more than realized by the railway companies, which now own practically all of the abutting property on both sides of the river, and they would profit greatly by the change.

FREIGHT-TERMINAL DEVELOPMENT

With the river thus straightened, it would be possible to so develop and rearrange the territory both east and west of the river, that the freight capacity and facilities of the railway companies would be greatly increased. This would make it possible to handle all the freight business to and from the business district for many years, so that there would be no occasion now or in the far distant future for the acquirement of additional property for freight facilities in this district.

Whether the river is straightened or not, the available areas can be developed to such an extent as to make it unnecessary for the Pennsylvania to develop its proposed new freight area in the manner set forth in its plans. There is also ample space available for all the freight facilities needed by all of the companies, if they will pool their issues and develop the territory as thoroughly as it is capable of being developed, by using modern and efficient methods.

Since the Union Station (Pennsylvania) group of roads has been able to coöperate upon a union passenger terminal, the same roads should be able to coöperate among themselves and with the other roads concerned upon a method for developing their freight facilities.

Finally, if the railway companies have acquired and continue to acquire additional real estate in the congested business district lying north of 12th St., east of Halsted St., and south of Chicago Ave., they should be required to place all tracks in covered subways and to cover their property occupied by these tracks by modern storage houses or business blocks which will earn a revenue in addition to that earned by the freight facilities.

THROUGH ROUTING FOR SUBURBAN TRAFFIC

With the terminal station system noted above, all roads from the east and south should use the Illinois Central station. All of those entering from the southwest, west, northwest and north should use the new station west of the river, unless a connection should be made by means of a tunnel whereby the roads from the northwest (such as the Chicago, Milwaukee & St. Paul and the Chicago & Northwestern) could be carried eastward, probably under Ontario St., to connect through a tunnel under the river with the Illinois Central tracks south of Randolph St.

This would bring some of the suburban trains of these roads into the Illinois Central station, while their other subur-

ban trains would run through the west side station to the south end and southwest over the tracks of the Pennsylvania and other roads. This would create an ideal intramural and interurban system of transportation by means of the through-routing features of these stations, and the proper interconnecting of the various railways.

With such an arrangement the present business district, instead of being blocked by railway terminals in three directions, would be paralleled on either side with an efficient and convenient through-route suburban service tending to lengthen and spread this district.

By means of this through connection between the stations, through passengers could easily transfer between the stations. But should it be deemed advisable to so group the roads that Eastern and Western roads could be connected in the same station, and thus make convenient the transfer of passengers between certain roads, this could be accomplished in many instances, without grade crossings or track elevation, by exchanging the use of tracks now running parallel for some miles on the same grade.

By the same principle of through-routing and connections between main stations, the sleeping cars and trains of different roads could, if desirable, be routed through Chicago.

In justification of this recommendation, I may call attention to the fact that my 1902 report to the city council upon the local traction situation, then in a chaotic condition, recommended the adoption of universal through-routing for the surface-car lines. The principles of this were embodied in the 1907 ordinances, and after 11 years of persistent effort on the part of the public, these principles have been accepted and adopted by the companies, as evidenced by the unification ordinance passed by the city council on Nov. 13, 1913.

In like manner, my report to city council in 1906 advocated the through-routing of the trains of the elevated roads, the benefits of which method of operation were achieved on Nov. 1, 1913.

Both of these instances are under conditions that will be profitable to the companies. Both recommendations were considered impracticable at the time they were made, and were strenuously opposed by the operating companies. But time and a persistent effort on the part of those who believed in them have proved the recommendations correct, and I believe that the recommendations herein made with reference to the through-routing of the steam railway suburban (if not the through) service will in time prevail.

If the plan should be adopted of stopping all main-line trains at 12th St., the present La Salle station could be retained in service and utilized as the suburban terminal of such eastern, southern and southwestern roads as use these 12th St. terminals for through passenger trains, provided the tracks leading to the La Salle station were placed underground and covered north of 12th St.

It would also be possible to extend two tracks north under La Salle St. and through the present La Salle St. tunnel under the river to a connection with the east and west subway on Ontario St. mentioned above. This would provide high-speed suburban service directly through the center of the entire business district. By the construction of a street-car subway on Clark St., the La Salle St. tunnel (which is owned by the city) could be abandoned for street railways and used as above.

REVIEW OF REPORT BY MR. WALLACE*

While I concur with Mr. Wallace in certain of his recommendations as to physical matters, I do not concur with him as to policy, wherein he states that nothing can be done with the present railway companies regarding the vacating or the development of their present properties until such time as they voluntarily see fit to act.

It is not apparent that many of the roads will not be willing to voluntarily undertake to solve the terminal problem on broad lines, and coöperate in such a plan, provided it recognized the rights of all roads on an equitable basis. Neither is it to be taken for granted that roads now holding preferential positions cannot be required to join in such a plan, the contention of some of the interested roads to the contrary notwithstanding.

Chicago has succeeded in the face of strong corporate opposition, in establishing universal through-routing of its surface and elevated transit lines. It is fair to assume that if it undertakes to secure similar and other reasonable benefits for its citizens at the hands of the steam railway companies, it will succeed in the end, through moral suasion or proper municipal or state regulation.

Especially is this true when it is considered that the city is now developing a rapid-transit subway system in connection with elevated and surface lines. The location of railway passenger terminals on such sites as to properly coördinate with this system is one of the fundamental things to be considered and safeguarded by both the city and the companies.

Mr. Wallace's recommendations in effect permit the Pennsylvania and associated companies to erect their union station in the location asked for, and without any change in the general arrangement of the station, tracks, facilities or roadways adjacent thereto. They permit the Pennsylvania R.R. to build its new freight terminal as contemplated, but removed one block south, and with a dpressed but not necessarily covered track entrance instead of an overhead approach, as originally proposed.

I regard the present location of the union station as one of last resort, incapable of future expansion, and not at all located with reference to the recognized trend of business movement southward, or in conformity with the general policy of coöperation between the roads in working out a better solution.

I am entirely in disagreement with any recommendations for a new freight terminal in the position proposed, not only for the reason that it would hurt instead of help West Side development, but principally for the reason that the additional area is not needed. The roads have room enough already, for their needs if they will develop their properties more efficiently.

His recommendation for the confinement of terminal facilities within established or widened street building lines is fully concurred in by me. The Illinois Central site I have studied for some time, and I concur with Mr. Wallace as to the desirability of this site for a station for roads from the south and east.

As the result of my study, I am convinced that the city should grant no further ordinances to railways seeking to rebuild their present terminal facilities or to construct new terminals, unless the ordinances contain definite provisions making the following fundamentals mandatory upon the roads benefited by the ordinances:

1. Coöperation with other railways and with the city in straightening the river, and in opening streets now blocked by railway property.

2. Placing all tracks (with certain exceptions) in covered subways within the district bounded by 12th, Halsted and Lake Sts.

3. Concentration of long-distance passenger traffic into the smallest practicable number of terminals, and at such location as will offer the least obstruction to the extension of the business district, but consistent with reasonable accessibility.

4. Coöperation with other railways and the city in the development of the property owned by various railways within or contiguous to the business district.

5. Where streets or alleys are closed, temporarily or for long periods, the railway to give an equivalent area or value in widening other streets.

6. The city to retain control over subsidewalks and subpavement space, not specifically vacated by ordinance, that may be required for suburban transportation systems or other public utilities.

7. Coöperation with the city in establishing elevated thoroughfares across the railway property lying between the river and Canal St.

8. Provision for a marginal way or river road on the west side of the river between Lake and 16th Sts., and the development of suitable docking facilities.

9. Provision in all new passenger stations for through connected or interchange tracks, so as to permit interchangeability of suburban service between roads operating in different parts of the city.

10. Coöperation with other roads to interchange the use of coach-yard facilities, if necessary to carry out the through-routing or interchange principle for suburban service.

11. Coöperation with other railways in the working out of a general plan whereby the roads may be systematically grouped and brought into two or more terminal stations with the least amount of track.

12. Coöperation with other railways and the city in establishing universal facilities at some outlying point for the interchange of package freight now interchanged in the downtown district.

13. The removal of obstructions due to railway occupancy which decrease the width of the river channel, so as to permit the construction of bridges without encroaching upon this channel.

14. Double-decking Canal St. will make property west of that street available for freight purposes if tracks are kept underground and the property is developed overhead for business or manufacturing purposes.

*An abstract of this report by Mr. Wallace was given in "Engineering News," Nov. 6.

15. As the Chicago Plan Commission has done such ex-nsive and commendable work for the betterment of Chicago, e city authorities should see that no structure is reared any railway company which will prevent the ultimate real-ation of such parts of the original plan laid down by Mr. rnham as have met with the official approval of the Chicago an Commission.

The easiest thing for the city to do is to require nothing nd to let the railways have what they ask. The most diffi-lt thing for the city to do is to require the railway com-anies to carry out the plan best suited to the entire city at their own expense. The just thing to do is to join with the oads in carrying out, on some equitable basis, a plan which will gradually put into effect such recommendations in this report and that of Mr. Wallace as are considered sound. And some practicable method should be formulated for such a procedure.

A Disastrous Sewer Explosion in Pittsburgh

A sewer explosion in Pittsburgh a week ago wrecked about a mile of 8-ft. brick trunk sewer. The sewer was in large part destroyed, many sections of the street blown out or upheaved, several buildings damaged, the discharge of the sewer blocked, and further damage threatened by undermining and settlement. No lives were lost, but several persons were injured by falling débris. Emergency work was begun the same day under special action of the city authorities. The following authoritative account furnished to ENGINEERING NEWS from official sources sketches the results of the accident briefly.

FIG. 1. HOUSES WRECKED AND STREET FLOODED NEAR UPPER END OF SEWER

FIG. 2. PITTSBURGH SEWER EXPLOSION. SEWER ARCH AND STREET BLOWN OUT, NEAR LOWER END OF SEWER

At 2:30 p.m., Tuesday, Nov. 25., 1913, a violent explosion wrecked the lower end of the 33d St. trunk sewer from its outlet at the Allegheny River about 5000 ft. up. It was an 8-ft. brick sewer. Large sections of the street collapsed after the explosion and subsidence continued subsequently. A number of catch basins and manholes were blown out. The surface evidences were such as to indicate that the sewer arch had been totally destroyed for a large part of the length involved. The violence of the explosion seemed to be about equal over the full distance.

Considerable property damage was done by the explosion direct, and more damage done and threatened by the flooding which resulted from obstruction of the sewer. A heavy brick building 20 ft. from the sewer had its stone foundation damaged and the wall distorted. Several wooden tenements near the upper end of the wrecked section of sewer were destroyed or damaged. The flow of the sewer backed up because of the blocking of the sewer; it flooded the area along the tracks of the Pittsburgh Junction R.R., and threatened the collapse of a large brewery and a number of other buildings.

The sewer is located in 33d St. from the river to Liberty Ave., where it passes near the Carnegie Upper Union Mills and a number of other industrial plants; thence it follows Sassafras St. some 3000 ft. up Junction Hollow, paralleling the Pittsburgh Junction R.R., past numerous industrial plants.

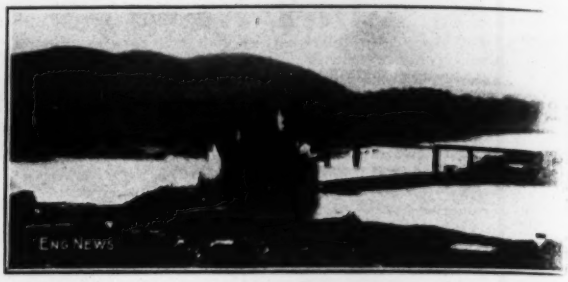
Emergency maintenance and repair work was begun the same day through prompt action by the city officials. The City Councils provided $50,000 for immediate work, and a preliminary force-account contract was made with John F. Casey Co., contractors, late the same evening. On the following morning, Nov. 26, work began, stripping the sewer at the 33d St. crossing, sheeting the trench, etc. By the end of the week the sewer had been opened from Liberty to Penn Aves., about 400 ft., for which length the sewer was thoroughly shattered. In the lower 1000 ft., from Penn Ave. to the river, the sewer is holding, but its exact condition is unknown; heaved pavement indicates that this section also is disturbed. Near the river a critical situation was produced by collapse of the sewer and blocking of its mouth. This was handled by excavating down and crushing in the sewer with a 3-ton drop weight, sheeting the trench for protection.

The dry-weather flow of this sewer is about 25,000,000 gal. per day. This is being carried above Liberty Ave. in a ditch along the railroad track. Just above Liberty Ave. the flooding endangered the foundations of a brewery and the stability of the railroad embankment. There was great difficulty opening a passage for the flow at this point. The railroad tracks were piled and steel sheeting was driven to hold the banks. Later the flow went through the piled opening.

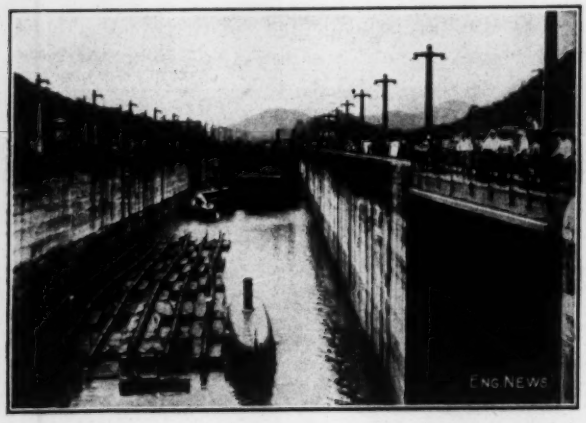
The situation is still not past the critical stage, particularly in case of rain, as the sewer is on the combined system.

Reconstruction work is being continued day and night. A force of 500 men is engaged in the work. Operations are in charge of the Department of Public Works (W. L.

Entrance of Water into Upper Gatun Lock below Intermediate Gates. Sept. 26, 1913.



Blowing Up Gamboa Dike. Oct. 10, 1913



Dredging Fleet from Pacific End in East Chamber of Pedro Miguel Locks. Oct. 24, 1913

Opening a Ditch across the Cucaracha Slide. Oct. 11, 1913

General View of Gatun Middle and Lower Locks Looking North from Lighthouse. Oct. 27, 1913

Suction Dredges at Work on Cucaracha Slide. Oct. 28, 1913

Recent Views on the Panama Canal Work

English, Director of the Department; N. S. Sprague, Superintendent of the Bureau of Construction).

Two views herewith show some of the effects of the explosion. Fig. 2, near the crossing of Penn Ave., shows the sewer arch and the street above blown out. Fig. 1 is a view along the railway tracks near the upper end, where houses were destroyed and damaged by the explosion and the flooding resulting from the obstruction of the sewer.

Electrification of the St. Gotthard Railway

For a considerable time past work has been in progress on the development of plans for electrifying the mountain section of the Gotthard summit crossing in Switzerland including the 9-mile tunnel. The management of the Swiss Federal Rys. maintains a separate electrification department for working out electrification projects on the Federal railway system. The plans for the St. Gotthard have reached a pretty definite state, and a few weeks ago the government took the first step toward appropriating the money required for the work. A sum between $5,000,000 and $10,000,000 will probably be needed for the Gotthard project.

The official project for the Gotthard electrification contemplates installing electric equipment from Erstfeld, on the north approach, to Bellinzona on the south. The electric system will not be materially different from that used in the Loetschberg line, where single-phase 15,000-volt current is employed with one overhead conductor. The Gotthard line is to be insulated for 15,000-volt operation, but it is thought that until the growing traffic makes the full tension necessary the line voltage will be held down to 7500.

The Gotthard Ry. has maximum grades of 2.7% and on both sides the approaches are full of development to gain length, including spiral tunnels, etc. Thus the traction conditions are difficult at best. It is probable that trains will be operated with two locomotives, one at the rear as pusher.

The power-supply system as it has been worked out includes two power plants, one at Amsteg on the north approach, with a hydraulic head of 920 ft., and one at Ambri Piotta on the south approach, with head of 2600 ft. The hydrological characteristics of the two areas are different, but the two plants supplement each other. The south plant has small aggregate energy-capacity, but has lake storage, while the north plant lacks equalization but has a large summer capacity. The load will be divided between the two plants according to the seasonal conditions to take advantage of the high summer flow at Amsteg and utilize the storage in the south plant for winter supply.

NOTES

A Railway Collision Occurred at Ceccano, Italy, on Nov. 29, when the evening express from Rome for Naples ran into a locomotive. Seven passengers were killed and 25 were wounded.

A Fire, on Nov. 26, destroyed the railroad shops of the Grand Trunk Ry. System, at Port Huron, Mich., according to press dispatches. The shops employ about 1000 men.

A Tank Car Explosion blew a man who was in the car through the dome of the car and through the sheet-iron roof of the repair shop of the Pennsylvania Tank Car Co., at Sharon, Penn., on Nov. 24.

A Burning Vessel was sighted at 1 a.m., on Nov. 19, about 15 mi. out in the English Channel, off Ventnor, Isle of Wight. Examination showed her to be the s.s. "Scotsdyke," of Glasgow, Scotland. She had been abandoned.

A Derailment, near Coldwell, Ont., on Nov. 21, caused the locomotive of the first section of the Imperial Limited, of the Canadian Pacific Ry., to plunge into Lake Superior. The accident was caused by a rock which, loosened by a recent storm, fell upon the track at a point where the track skirts a ledge 30 ft. above the lake. The fireman was killed.

A Curious Underground Fire occurred south of the city of Savannah, Ga., a few feet under the surface of the ground, according to press dispatches of Nov. 27. The fire is in an old city garbage dump of 10 acres extent and is about a mile from the nearest fire-hydrant, so that there is no way to get water to it.

The Patent Infringement Suit of the Cameron Septic Tank Co. vs. the City of Monmouth, Ill., was dismissed in the United States Court at Peoria, Ill., on Nov. 11, on the ground that the plaintiff had failed to prosecute the suit for two years. The suit was originally brought about eight years ago.

The Official Opening of the Cape Cod Canal will be on July 4, 1914, according to a letter from Superintendent J. W. Miller, of the canal company, to the directors of the Cape Cod Board of Trade, made public on Nov. 29. A pageant is to be arranged in celebration of the event. Beginning at the head of Buzzard's Bay the canal cuts through Cape Cod to Massachusetts Bay, at Sandwich, Mass., making it possible for coasting vessels to avoid the dangerous shoals of the present route.

A Steel Lunch-Counter Car was placed in service by the Pennsylvania R.R. on Dec. 1, between New York and Philadelphia on trains which also carry dining cars. The car is 80 ft. in length and has, instead of tables, a long mahogany counter extending over half the length of the car, with sufficient capacity to serve 21 people seated on revolving mahogany chairs facing the counter. While the number seated is no greater than in a standard dining car, it is hoped to be able to serve them more rapidly.

The North Poudre Irrigation Co. Tunnel, 25 miles northwest of Fort Collins, Colo., was completed and dedicated Nov. 13. The tunnel is 4892 ft. long with a cross-section 6½x8 ft. Work was begun in the fall of 1912 and the time set for completion was Apr. 1, 1914, but the work progressed so rapidly that by Nov. 6, last, the job was practically completed. The contractor was Swan, Patterson & Co. and the contract price is said to have been $75,000, or a little more than $15 per lin.ft. of tunnel, which makes it compare most favorably with any similar work done in the West. E. C. McAnelly, now Deputy State Engineer of Colorado, was formerly the engineer in charge. When he was appointed to his present office he was succeeded as engineer in charge of the tunnel work by James H. Andrews, of Fort Collins.

State Railroad Commissioners' Valuation Committee—The Interstate Commerce Commission has asked the various state railroad commissions to coöperate in the physical valuation of the railway properties about to be undertaken. This matter was taken up at the recent convention in Washington, D. C., of the National Association of Railroad Commissioners, and the President of the Association has been empowered to appoint a committee of 15, three members to each of the five districts, to look after the interests of the state-railroad or public-service commissions of their districts. The first meeting of this committee has been called to be held in Chicago, Ill., Dec. 10. At this meeting organization will be effected and an outline of the work to be undertaken by the committee perfected.

Wireless Telegraphy for control of trains moving en route has been experimented with by the Delaware, Lackawanna & Western R.R. for several months. Finally the "Lackawanna Limited," a train running between Hoboken, N. J., and Buffalo, N. Y., was equipped. On Nov. 21, communications were exchanged between the moving train and fixed stations at Binghamton, N. Y., and Scranton, Penn. On Nov. 23, more practical use was made of the trial service by arranging for a relief conductor and extra coaches. The trials are to be continued every other day for the present.

An operator's room has been built in the second car from the front of this train. The aërial wires are stretched flat between the ends of each of the first four cars and about 2 ft. above the roof, so that the station is about under the center

of the antennæ, the four aërials of the cars being electrically connected. High aërials are used at the fixed stations. Current is taken from train-lighting generators. The rails are found to give a satisfactory ground connection. The experiments have been carried on by L. B. Foley, Superintendent of Telegraphs, D. L. & W. R.R., and David Sarnoff, Chief Inspector, Marconi Wireless Telegraph Co.

The Interstate Railway Valuation Board of Engineers has made no appointments to subordinate positions as yet, and we are informed that it is improbable that any appointments will be made before the first of the new year. It is also stated that the number of appointees to be made in each grade is problematical, as the positions will be filled from time to time as the work becomes more fully organized and developed. It is now well understood that the executive officer of the Board will be Hon. Charles A. Prouty, whose resignation from the Interstate Commerce Commission is now in the hands of the President. The five engineer members of the Board as probably most of our readers know (see "Engineering News," May 15, 1913, p. 1019) are H. M. Jones, Municipal Bldg., Chattanooga, Tenn.; W. D. Pence, Karpen Bldg., Chicago, Ill.; R. A. Thompson, Wells, Fargo & Co. Bldg., San Francisco, Calif.; Edwin F. Wendt, Epiphany Bldg., Washington, D. C., and J. S. Worley, Y. W. C. A. Bldg., Kansas City, Mo. The five District Engineers, in direct charge of the work in each district under the general supervision of the members of the Board of Engineers were appointed last July and are: John Y. Bayliss, Chattanooga; De Witt V. Moore, Chicago; F. L. Pitman, San Francisco; Frank Rhea, Washington, and Carl C. Witt, Kansas City. Our issue of Nov. 13, 1913, p. 990, contained the results of examinations for Senior Civil Engineer, Senior Structural Engineer and Senior Railway Signal Engineer. Below are given the results of the examinations for Junior Civil Engineer and Mechanical Engineer:

JUNIOR CIVIL ENGINEER

District I:	Above 90%	80-90%	70-80%
First grade	1	28	70
Second grade		11	44
District II:			
First grade		1	11
Second grade		2	7
District III:			
First grade		2	12
Second grade		5	7
District IV:			
First grade		7	26
Second grade		1	10
District V:			
First grade		7	18
Second grade		1	4
Totals	1	65	209
Grand total	275		

MECHANICAL ENGINEER (one grade only)

	Above 90%	80-90%	70-80%
District I	2	5	7
District II	1	4	4
District III	2	2	2
District IV	1		1
District V		1	2
Totals	6	12	16
Grand total	34		

As stated in our issue of Nov. 13, the appointments in each of districts are to be made from eligibles in that district so far as possible. The states included in each district were given on p. 990 of our issue of Nov. 3.

As to the extent of the field operations of the work to be done, Mr. Prouty is quoted by the Indianapolis, Ind., "News," as follows:

We will probably put out about 150 surveying parties, covering the whole country. There will be about eight men in each party, making a total of 1200 or thereabouts in this branch of the work alone. The problem of organizing and transporting these has not been an easy one. We will probably decide to give each party a special car to transport its people and equipment and provide quarters in which to live while working through the country.

PERSONALS

Mr. F. L. Lewis has been appointed General Superintendent of the San Antonio, Uvalde & Gulf R.R., with headquarters at Pleasanton, Tex.

Mr. Reid Tull has resigned as Resident Engineer of the Piedmont & Northern Lines, Spartanburg, S. C., to become City Engineer of Spartanburg.

Mr. C. L. Wallace, Office Engineer of the Kansas City Southern Ry., at Kansas City, Mo., has been appointed Assistant Chief Engineer and assigned to service with the railway's valuation committee.

Mr. H. A. Guess, M. Am. Inst. M. E., formerly General Manager of the Federal Lead Co. plant at Flat River, Mo., has been appointed Consulting Engineer of the company with headquarters at New York City.

Mr. Frank O'Brien, recently Assistant Superintendent of the Wisconsin division of the Chicago & Northwestern Ry., has been promoted to be Superintendent of the new Southern Illinois division, at South Pekin, Ill.

Mr. A. M. Baird has been appointed Assistant Superintendent in charge of locomotive shops of the Atchison, Topeka & Santa Fé Ry. His headquarters will be in Topeka, Kan. He succeeds Mr. R. F. Whalen, resigned.

Mr. C. L. Newcomb, Jr., has been appointed Western Representative of the Goulds Manufacturing Co., Seneca Falls, N. Y., with headquarters at 12 Chamber of Commerce Bldg., Denver, Colo., succeeding Mr. G. B. Turner.

Mr. C. F. Gailor, in charge of engineering, construction and roadway on the Hartford, Conn., lines of the Connecticut Co., has resigned to become Assistant Chief Engineer of the United Railways & Electric Co., Baltimore, Md.

Mr. C. F. Stoltz has been appointed Signal Engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry. and the Peoria & Eastern Ry., with headquarters at Cincinnati, Ohio, succeeding Mr. L. S. Rose, assigned to other duties.

Mr. J. W. Porter, Assoc. M. Can. Soc. C. E., Division Engineer of the Trans-Continental Ry., of Canada, has been appointed Chief Engineer of the Hudson Bay Ry., succeeding Mr. J. H. Armstrong, M. Can. Soc. C. E., resigned, as noted in our issue of Nov. 20.

Mr. C. V. Kerr, M. Am. Soc. M. E., formerly of the Kerr Turbine Co., and recently Chief Engineer of McEwen Bros., Wellsville, N. Y., has joined the staff of the centrifugal pump department of the A. S. Cameron Steam Pump Works, 11 Broadway, New York City.

Mr. Joseph H. Gumbes, Assistant Superintendent of the Pennsylvania R.R., Pittsburgh division, at Youngwood, Penn., has been promoted to be Superintendent of the Renovo division, succeeding Mr. W. G. Coughlin, promoted, as noted elsewhere in these columns.

Mr. George Westinghouse, Past-President of the American Society of Mechanical Engineers, was presented with the Grashof Medal of the Verein Deutscher Ingieure, on Dec. 5, at the annual meeting of the American Society of Mechanical Engineers in New York City.

Mr. F. H. Stephenson, Assoc. M. Am. Soc. C. E., recently Assistant Engineer, Filtration Division, Department of Gas, Water Supply asd Electricity of the City of New York, has been appointed Assistant Engineer of the projected municipal filtration plant at Cleveland, Ohio.

Mr. J. M. Henry, Master Mechanic of Pennsylvania R.R., at the West Philadelphia, Penn., shops, has been promoted to be Superintendent of Motive Power of the Western Pennsylvania division at Pittsburgh, Penn., succeeding Mr. John M. James, promoted, as noted elsewhere.

Mr. E. E. Nash, Superintendent of the Madison division of the Chicago & Northwestern Ry., at Baraboo, Wis., has been promoted to be Assistant General Superintendent of the lines east of the Missouri River, except the Iowa, Minnesota and Dakota divisions. His headquarters will be at Chicago, Ill.

Mr. F. E. Bates, recently Assistant Engineer in the office of the Engineer of Design of the Chicago, Milwaukee & St. Paul Ry., Chicago, Ill., has been appointed Chief Draftsman of the bridge department of the Missouri Pacific Ry., at St. Louis, Mo. Mr. Bates is a graduate of the University of Wisconsin, class of 1910.

Mr. George L. Bean, M. Am. Soc. C. E., has completed his engagement with Mr. Henry Floy, M. Am. Soc. C. E., Consulting Engineer, New York City, in connection with the appraisal of the water-works system of the Elmira Water, Light & R.R. Co., Elmira, N. Y., and his address is now 1729 N. 19th St., Philadelphia, Penn.

Mr. W. M. Corse has resigned as Works Manager of the Lumen Bearing Co., Buffalo, N. Y., to become General Manager of the Empire Smelting Co., Depew, N. Y., effective, Jan. 1, 1914. Mr. Corse will be succeeded as Works Manager by Mr. H. P. Parrock, M. Am. Soc. M. E., present Sales Manager; the offices of Sales Manager and Works Manager are to be combined.

Mr. John M. James, Superintendent of Motive Power of the Pennsylvania R.R., Western Pennsylvania division, Pitts-

burgh, Penn., has been promoted to be Assistant Superintendent of the Pittsburgh division, succeeding Mr. Joseph H. Gumbes, promoted, as noted elsewhere. Mr. James entered the service of the Pennsylvania R.R. in 1893, after a two years' course at Ohio State University, as a special apprentice at the Altoona shops.

Maj. R. R. Raymond, Corps of Engineers, U. S. A., who since 1910 has been in charge of the improvement of the harbor of Wilmington, Del., and the Christiana River and of all the work in the Wilmington district, including Absecon Inlet, Atlantic City, N. J., has been ordered to Los Angeles, Calif., to take charge of the new United States Engineer district established there. He will be succeeded at Wilmington by Capt. E. N. Johnson, at present Assistant to the Chief of Engineers at Washington, D. C.

Mr. S. G. Strickland, Assistant General Manager of the Chicago & Northwestern Ry., has been promoted to be General manager of the lines east of the Missouri River, succeeding Mr. W. D. Cantillon, resigned. Mr. Strickland's railway experience began in 1877 as a telegraph operator with the Canadian Pacific Ry. He went to the Chicago & Northwestern Ry. in 1908 as Assistant General Superintendent, after serving in various capacities with Chicago, St. Paul, Minneapolis & Omaha R.R., at Omaha, Neb., and St. Paul, Minn.

Mr. S. H. Reynolds, M. Can. Soc. C. E., for seven years Assistant City Engineer of Winnipeg, Man., and recently Managing Director of the Pacific Coast Coal Mines, Ltd., Victoria, B. C., has been appointed Chairman of a commission to have charge of the construction and operation of a $13,500,000 water-supply system for the Greater Winnipeg Water District, Man. Mr. W. G. Chace, M. Can. Soc. C. E., of Kerry & Chace, Ltd., Toronto, Ont., is Chief Engineer of the Water District, as noted in our issue of Nov. 6. The source of the water supply is to be the Lake of the Woods at a distance of approximately 96 miles from Winnipeg.

Mr. H. M. Stone, M. Am. Soc. C. E., has resigned as Chief Engineer of the Chicago, Rock Island & Gulf Ry., at Fort Worth, Tex. Mr. Stone's railway experience began in 1877 as a rodman on the Pennsylvania R.R. In 1881 he went to the Denver & Rio Grande R.R. as Resident Engineer, and the next year to the St. Louis, Iron Mountain & Southern Ry. as Locating Engineer. From 1883 to 1894 he had charge of survey and construction work for various railways in the Mississippi Valley as Resident and Assistant Engineer. From 1894 to 1897 he was in general engineering work in Chicago, Ill., and then for two years was Chief Engineer of the Inverness & Richmond Ry., Cape Breton, Nova Scotia. His service with the Rock Island lines dates from January, 1903, when he was appointed Division Engineer. In 1905 and 1906 he was in charge of deep foundation work for the Kaw River bridge at Kansas City, Mo.

Mr. W. G. Coughlin, recently Superintendent of the Renovo division of the Pennsylvania R.R., has been promoted to be Engineer of Maintenance-of-way, succeeding the late L. R. Zollinger, M. Am. Soc. C. E. Mr. Coughlin was born at Florence, N. J., in 1862 and at 16 years of age joined the engineering corps of the Madeira & Mamoré Ry. in Brazil, the fortunes of which are well known to engineers. Returning to this country in 1879, after the failure of the Brazilian enterprise, he served as rodman on surveys in Pennsylvania until October of that year when he first entered the employ of the Pennsylvania R.R. as a rodman in the construction department. Subsequently he was Assistant Supervisor of the Northern Central Ry. (a Pennsylvania R.R. subsidiary), Supervisor of the West Jersey R.R. (another subsidiary), and in March, 1893, he was promoted to be Assistant Engineer of the Baltimore division of the Northern Central Ry at Baltimore, Md. He was promoted to be Principal Assistant Engineer of the same railway in 1900, and three years later left the engineering for the operating department as Division Superintendent of the Elmira and Canandaigua divisions, at Elmira, N. J. Since April, 1907, he has been Superintendent of the Renovo division of the Pennsylvania R.R., at Renovo, Penn.

Mr. D. J. Brumley, M. Am. Soc. C. E., recently Engineer of Maintenance-of-way of the Illinois Central R.R., has been promoted to be Assistant Chief Engineer, with headquarters at Chicago, Ill. Mr. Brumley is a graduate in civil engineering of Ohio State University, class of 1885. His railway experience began in 1895 as an assistant section foreman on the Louisville & Nashville R.R., and his subsequent career is typical of the ups and downs, or rather downs and ups, of a railway civil engineer's life. For six months in 1896 he was Assistant Engineer of the Columbus & Hocking Valley Coal & Iron Co., after which he returned to the Louisville & Nashville R.R. as an assistant supervisor, later becoming a section foreman. For a year, May, 1897, to May, 1898, he was a rodman with the engineering corps of the same road. In 1898 he was promoted to be Assistant Engineer. Three years later Mr. Brumley became Engineer of Maintenance-of-way of the Mexican National R.R., at Laredo, Tex., but returned in October of the same year, 1901, to be Roadmaster of the Louisville & Nashville R.R., at Elizabethtown, Ky. In October, 1904, he was appointed Division Engineer of the Indianapolis Southern Ry., at Indianapolis, Ind. In March, 1905, he was made Principal Assistant Engineer of the Illinois Central R.R. at Chicago, Ill., and from 1910 to April of the present year he was Engineer of Construction for the same railway. Since last April he has been Engineer of Maintenance-of-way.

OBITUARY

Russell D. Willson, Assoc. M. Can. Soc. C. E., Assistant City Engineer of Winnipeg, Man., was killed, Nov. 18, by accidentally coming in contact with a live wire carrying 13,000 volts at one of the city's water-supply wells.

Alexander A. Boutell, President of the Detroit Graphite Co., died at Atlantic City, N. J., Nov. 15. He was 63 years of age. He served in the Civil War, and was at one time Secretary of the Detroit (Mich.) Board of Commerce.

Andrew R. Edwards, for many years Superintendent of the Passaic Water Co., died at his home in Paterson, N. J., Nov. 21. He was a veteran of the 13th New Jersey Volunteers during the Civil War and was seriously wounded at the battle of Antietam.

Stephen Bull, one of the founders and for many years President of the J. I. Case Thrashing Machine Co., of Racine, Wis., died at his home in that city Nov. 15, at the age of 91 years. He was born in Cayuga County, N. Y., in 1822 and went to Racine in 1845.

Guy A. Du Bois, President and General Manager of the Byron Jackson Iron Works, San Francisco, Calif., and designer of the Du Bois gold dredge, died Nov. 11, at his home in Berkeley, Calif. He was 45 years old and a native of New York. He is survived by a widow and four children.

Alfred Williams, President of the Ocean Shore Ry., of San Francisco, Calif., died in Seattle, Wash., Nov. 13. He had formerly held positions in the engineering departments of the Chicago, Burlington & Quincy R.R., and other railways about Denver, Colo. He was associated with the late E. C. Hawkins and others in the building of the White Pass & Yukon and the Copper River & Northwestern Rys. in Alaska.

Sir William H. Bailey, Chairman and Managing Director of the W. H. Bailey & Co., Ltd., Albion Works, Salford, England, and one of the original promoters of the Manchester Ship Canal, died in London, Nov. 22. He was also a director of the Manchester Ship Canal Co. and the Ebbow Vale Steel & Iron Co. He was knighted by Queen Victoria on the first ship through the Manchester Ship Canal at the opening ceremonies in 1894.

Thomas Martin Emerson, President of the Atlantic Coast Line Ry., died at his home in Wilmington, N. C., Nov. 25, from acute indigestion. He was born in Preble County, Ohio, in 1851 and entered the railway service in 1867 as a clerk in the freight office at Hagerstown, Ind., of the Fort Wayne, Muncie & Cincinnati R.R. He served in various clerical capacities on Central, Western and Southern railways until 1891 when he was made Traffic Manager of the Atlantic Coast Line Ry. He had been President since 1905.

Richard Godeffrey, a retired civil engineer, died at his home in Clifton, N. J., Nov. 25, aged 67 years. He was connected with the construction of the dome of the Congressional Library in Washington, D. C., the League Island Navy Yard improvements at Philadelphia, Penn., and the construction of the water-works of the East Jersey Water Co., at Boonton, N. J., under Mr. Waldo Smith, Chief Engineer. Mr. Godeffrey was born in Hamburg, Germany, and educated at the University of Hanover. He came to this country in 1887, after having done considerable engineering work on railways and bridges in Germany. He retired from active work about 10 years ago.

William Wilson Finley, President of the Southern Ry., died in Washington, D. C., Nov. 25, from apoplexy. He was born at Pass Christian, Miss., on Sept. 2, 1853. He entered the railway service at 20 years of age as a stenographer in the office of the Vice-President of the New Orleans, Jackson & Great Northern R.R., and the Chicago, St. Louis & New Orleans R.R. Later he was clerk and secretary to various officials until 1883, when he was appointed Assistant General Freight Agent of the Texas & Pacific division of the Missouri Pacific Ry. He then served in the freight and passenger

traffic departments of various Western railways until April, 1895, when he became Commissioner of the Southern States Passenger Association. In October, 1895, he was elected 3rd Vice-President of the Southern Ry., 2nd Vice-President in 1896 and President in 1906.

George B. Post, Fellow of the American Institute of Architects since 1864, founder of the firm of George B. Post & Sons, Architects, New York City, died at his summer home at Bernardsville, N. J., Nov. 28. He would have been 76 years old on Dec. 15. He was a native of New York City and graduated in civil engineering at the School of Science, New York University, in 1858. After his graduation he studied architecture in the office of the late Richard M. Hunt. In 1860 he entered a partnership with Charles D. Gambrill for the practice of architecture, but at the outbreak of the Civil War he entered the Union Army as Captain in the 22nd New York Regiment. He served all through the Potomac campaigns of 1862-'63 and was promoted to be Colonel of his regiment. Returning to New York City after the war he resumed his practice as an architect and designed some of the city's most notable structures, among others the Cotton Exchange, the Produce Exchange and the New York Stock Exchange Buildings, the College of the City of New York, the Equitable Life Assurance Building, which was destroyed by fire two years ago, and many notable residences, including those of Cornelius Vanderbilt and C. P. Huntington on Fifth Ave. He also designed the buildings of the Prudential Life and Mutual Life Insurance Cos. in Newark, N. J., the Wisconsin State Capitol, the Cleveland (Ohio) Trust Co. and the Manufacturers and Liberal Arts Building of the World's Columbian Exposition at Chicago in 1892-'93. Mr. Post was a Chevalier de la Legion d'Honneur of France and in 1910 received the Gold Medal of the American Institute of Architects, the highest honor that society can bestow. He was President of the American Institute of Architects from 1896 to 1899, a member of the American Society of Civil Engineers, an honorary corresponding member of the Royal Institute of British Architects and a member of many other scientific and learned societies in this country and Canada.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 2-5. Annual meeting in New York. Secy., Calvin W. Rice, 29 W. 39th St., New York City.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.
Dec. 8-11. Annual meeting in New York. Secy., Percy H. Wilson, Land Title Bldg., Philadelphia, Penn.

SAND-LIME BRICK ASSOCIATION.
Dec. 9-10. Annual meeting at Harrisburg, Penn. Secy., W. E. Plummer, Jr., 211 Fillmore Ave., Buffalo, N. Y.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Dec. 9-12. Annual convention at Philadelphia, Penn. Secy., W. H. Tolman, 29 W. 39th St., New York City.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Dec. 10-13. Annual meeting in New York. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Dec. 11-12. General meeting in New York. Secy., D. H. Cox, 29 W. 39th St., New York City.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 29-31. Seventh annual convention at Chicago, Ill. Secy., I. W. Dickerson, Urbana, Ill.

MINING AND METALLURGICAL SOCIETY OF AMERICA.
Jan. 13. Annual meeting at New York City. Secy., W. R. Ingalls, 505 Pearl St., New York.

AMERICAN WOOD PRESERVERS' ASSOCIATION.
Jan. 20-22. Tenth annual convention at New Orleans, La. Secy., F. J. Angier, Timber Preservation Co., Baltimore, Md.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Jan. 21-23. Annual meeting in New York. Secy., E. A. Scott, 29 W. 39th St., New York City.

NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.
Feb. 12-14. Meeting at Chicago, Ill. Secy., J. P. Beck, 72 W. Adams St., Chicago, Ill.

Iowa Association of Cement Users—The next convention is to be held at Ames, Iowa, Jan. 8-10, 1914.

Texas Members of the American Society of Civil Engineers—At a meeting in Dallas, on Oct. 31, the Texas organization was formed with John B. Howley, President, and J. F. Witt, City Engineer, of Dallas, Tex., Secretary-Treasurer.

Exposition of Safety and Sanitation—At the First Annual Exposition to be held in New York, Dec. 11-12, under the auspices of the American Museum of Safety, the following awards will be made: the E. H. Harriman Memorial Medals; Safety Exposition Medals; and the annual medals of the Museum, consisting of the Travelers, Scientific American, Seaman and Rathenau medals.

American Institute of Electrical Engineers—At the regular monthly meeting of the Board of Directors, on Nov. 3, President Mailloux announced the acceptance by Dr. Charles Steinmetz of the appointment of Honorary President of the International Electrical Congress to be held at San Francisco, Calif., Sept. 13-19, during the week preceding the International Engineering Congress (Sept. 20-25).

American Institute of Chemical Engineers—In the program of the annual meeting to be held in New York, Dec. 10-13, the following papers are included: "Sanitary Control of the City of New York," Ernst J. Lederle, Commissioner, Department of Health; "Recent Developments in Commercial Explosives," E. A. Le Sueur; "Ozone, Its Manufacture and Use," Dr. A. Vosmaer. At 8 p.m., on Dec. 12, the members will attend a joint meeting of the American Chemical Society, Society of Chemical Industry and the American Electrochemical Society, at the Chemists' Club.

Land Grant College Engineering Association—The Association was organized in February, 1913, and includes the presidents and deans of engineering, or other representatives of engineering divisions, of the land-grant colleges in all the states. It is essentially a meeting of managers of the engineering work at these institutions to discuss important questions of policy and work in their administration. The second annual meeting was held in Washington, D. C., Nov. 11-14, coincidently with the meeting of the Association of American Agricultural Colleges and Experiment Stations. The Secretary is Dean G. W. Bissell, of the University of Michigan.

New England Water Works Association—At the December meeting to be held at the Hotel Brunswick, Copley Square, Boston, Mass., on Dec. 10, the following papers will be presented: "Rainfall," X. H. Goodnough, Chief Engineer, Massachusetts State Board of Health; "On Flow in Bends," N. W. Akinoff; "Small Water Purification Plants, a Plea for Their More Efficient Operation," H. P. Letton, Sanitary Engineer, Washington, D. C. There will also be a topical discussion on "A Comparison of Methods Used to Locate Hidden Leaks in Underground Pipes with Special Reference to Pipe Whose Actual Location is Unknown." Willard Kent, Secretary, Narragansett Pier, R. I.

American Society of Civil Engineers—The arrangements for the 65th annual meeting, to be held at the Society House, 220 W. 57th St., New York City, Jan. 21-22, 1914, have been placed in the hands of the following committee: Robert Ridgway, H. W. Hodge and Charles Warren Hunt. At the business meeting at 10 a.m., Jan. 21, the annual report will be presented, officers for the ensuing year elected, etc. On the two days following the annual meeting, viz., Jan. 23 and 24, three sessions of the Society will be held to discuss "Road Construction and Maintenance." These sessions are arranged as follows: Jan. 23, at 10 a.m.—"Engineering Organization for Highway Work"; at 2 p.m.—"Factors Limiting the Selection of Materials and of Methods in Highway Construction"; Jan. 24, at 10 a.m.—"Equipment and Methods for Maintaining Bituminous Surfaces and Bituminous Pavements."

Railway Fire Protection Association—The objects of this association, which was organized at Chicago, Ill., Oct. 7-8, are "to promote the interest in and improve the method of fire protection and prevention; to obtain and circulate information on these subjects, and secure the coöperation of its members in establishing proper safeguards against loss of property and life by fire, and especially to standardize practices through the interchange of ideas and experiences with regard to such matters in connection with railway properties."

At the Chicago meeting 39 members were enrolled and the following officers were elected: President, F. W. Elmore (Southern Ry. Co.), Washington, D. C.; Secretary-Treasurer, C. B. Edwards (Mobile & Ohio R.R.), Mobile, Ala.

On Oct. 8, the Executive Committee appointed members to serve on the following committees: Fire Hazards; Statistics and Forms; Fire Fighting Organization, and Fire Fighting Apparatus.

One of the papers presented at the meeting was by P. Hevener (Rock Island Lines) on "How a Locomotive May Be Used to Extinguish a Fire." The Rock Island R.R. has equipped 250 switch engines with an extinguisher of local origin. This device consists of two "Y" fittings connected to the feed pipe, one on each side of the engine. A 50-ft. hose with nozzle attached is placed in a box beneath the running board. The cost of the equipment (exclusive of the hose and nozzle) is $45 per locomotive. The water thrown is warm, but not scalding; the nozzle can be handled with gloves. Mr. Hevener spoke very highly of this device, and stated that several other railroads are using practically the same arrangement at the present time.